Technical Report 1213

Cognitive Task Analysis of the Battalion Level Visualization Process

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This technical report describes the results of a cognitive task analysis to identify important skill areas associated with visualization at the battalion level of command. The analysis consisted of a review of current U.S. Army doctrinal literature, a review of battalion visualization from a psychological perspective, and a series of interviews with military officers having recent combat experience in either a command position or as a battalion Operations Officer or Executive Officer. Bases on findings from the cognitive task analysis, 11 skill areas were identified as potential focal points for future training development. The findings were used to design and develop exemplar training exercises for selected skills. This report documents findings and recommendations from the cognitive task analysis, and describes the design, development, and field test of exemplar training vignettes used to evaluate the cognitive task analysis findings and recommended training methods.

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COGNITIVE TASK ANALYSIS OF THE BATTALION LEVEL VISUALIZATION PROCESS

EXECUTIVE SUMMARY

Research Requirement:

The ability to visualize the battlefield is a critical element of battle command. Current methods for training battlefield visualization, placing commanders in a realistic situation and hoping they "figure it out," are not sufficient. Focused, deliberate training is needed to accelerate the development of visualization skills. Before effective training can be developed it is first necessary to identify the critical cognitive behaviors expert commanders use to be effective. This technical report describes a cognitive task analysis undertaken to identify important skill areas associated with visualization at the battalion level of command. The report also describes the design, development, and field test of exemplar training vignettes used to evaluate the cognitive task analysis findings and recommended training methods.

Procedure:

The cognitive task analysis consisted of three components. First, a review of current U.S. Army doctrinal literature was undertaken to identify key structural and functional elements of battalion visualization. This review addressed visualization requirements as a general part of planning and executing combat operations and concentrated on stability operations currently undertaken in Afghanistan and Iraq. Second, battalion visualization was addressed from a psychological perspective. This review reflected current theories and findings from the fields of knowledge management and organizational psychology, as they applied to visualization at a battalion level of command. Lastly, the cognitive task analysis included a series of interviews with military officers having recent experience in either a command position or as a battalion Operations Officer (S-3) or Executive Officer (XO).

Findings:

An analysis of interviews conducted with field officers with recent combat experience revealed a number of "lessons learned" that were relevant to force on force and stability and reconstruction operations currently being conducted in Afghanistan and Iraq. Observations from these interviews amplified the findings of the doctrinal and psychological reviews, and provided areas of emphasis. From these three components of the cognitive task analysis, 11 skill areas were codified as potential focal points of future training development.

Utilization and Dissemination of Findings:

One immediate use of the cognitive task analysis is to inform the development of a training program that helps commanders learn the visualization process. Based on the results of the cognitive task analysis, an instructional process and proof-of-principle training products were developed and evaluated. The results clearly and unquestionably suggest that the Army needs to continue to develop training to address this key area of performance.

The findings from this research have been provided to the School for Command Prep at Fort Leavenworth, KS, and are being used to develop visualization training materials. The findings were briefed to GEN William S. Wallace, Commanding General, U.S. Army Training and Doctrine Command, on 24 July 2007.

COGNITIVE TASK ANALYSIS OF THE BATTALION LEVEL VISUALIZATION PROCESS

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COGNITIVE TASK ANALYSIS OF THE BATTALION LEVEL VISUALIZATION PROCESS

Introduction

Army doctrinal literature cites visualization as an essential part of battle command. Visualization results when the commander understands the higher commander's intent, his assigned mission, the enemy intent and purpose, and the friendly force's capabilities and limitations. Battlefield visualization includes the commander's view of what his forces will do and the resources needed to accomplish the mission. Ultimately, the commander's vision evolves into his intent and helps him develop his concept of operations.

Despite the frequent reference to this skill in Army literature, the concept of visualization lacks meaningful definition from either a cognitive, social, or ecological point of view. Lacking such a definition, it becomes difficult to characterize "good" visualization from that which is mediocre or inadequate. Without the ability to characterize specific performance goals, training or developing this skill in future commanders becomes problematic. In response to the need to develop training for visualization skills, this report summarizes the findings of a cognitive task analysis that focused on the visualization process of battalion commanders and their supporting staff at a tactical level of command.

This paper examines visualization from both an operational and psychological perspective, specifically as it is conducted at battalion command level in a complex environment such as that posed in recent stability and reconstruction operations. From an operational perspective, it is important to place the process of visualization in an appropriate work context—the planning and execution of military operations in a complex, often ambiguous, and evolving operational environment. In this regard, the present discussion begins with a review of U.S. Army doctrine as it discusses the nature and role of visualization within the overall command process. Next, the paper focuses on the conduct of stability, nation-building, and counter-insurgency operations—a context that is considered to be more cognitively challenging than traditional linear combat operations against an organized military force. Here, the paper draws observations—or lessons learned—from recent operations in Afghanistan and Iraq. These insights highlight how current doctrinal views of visualization must be adapted or interpreted in light of this more cognitively challenging environment.

From a psychological perspective, it is important to identify and characterize the key knowledge elements and socio-cognitive processes that enable effective visualization as a practiced skill. Here, we examine visualization on three levels of systems analysis: (1) the cognitive level that includes the internal mental structures and processes with which an individual commander builds his internal framework of understanding, (2) the social level that includes the mechanisms by which the commander identifies and utilizes other sources of expertise to augment and refine this framework of understanding, and (3) the ecological level that includes the ways in which understanding and action-taking mutually influence one another over the course of time. By considering visualization from all three perspectives, one gains a more complete understanding of how this skill can be developed in future battalion commanders.

Following this foundational discussion, the paper turns next to a series of observations drawn from the analysis of interviews conducted with commanders, executive officers, and S-3 operations officers who have had recent combat experience in either Afghanistan or Iraq. Together, these observations reinforce and illustrate the importance of certain visualization skills and, thus, point toward the development of future training objectives.

In a final section, the paper focuses on providing trainers with a concise definition of what is meant by the term "visualization." Definition of this term—in terms of behavioral training objectives, performance criteria, and measurement strategies—is only vaguely discussed in current literature, misunderstood, or ignored altogether. Given the stated importance of this broad skill area, however, it is essential that Army training developers come to an agreed understanding of what constitutes the important elements of "good" visualization. Only then will it be possible to specifically target training support packages at these elements in order to better equip Army officers for future operations.

Visualization: An Operational Perspective

We begin this discussion by examining the role and nature of battalion visualization in the broader context of battle command. In the first part of this section, the discussion highlights a number of characteristics of visualization as suggested by Army doctrine. While much of this doctrine focuses on operational level command processes and organizations, it is believed that some of the underlying principles apply to lower, tactical levels of command as well. In the second part of this section, we take a more focused look at the structural elements of this framework and discuss how the emergence of modern stability, counterinsurgency, and nation-building operations complicate the visualization process of the tactical commander. Together, these doctrinal elements and implied complications frame the identification and analysis of important visualization skills to be addressed in future training for battalion level command.

Doctrinal Role and Nature of Visualization in Battle Command

Field Manual (FM) 3-0, June 2001a, *Operations*, refers to visualization in several ways: (1) it is purposeful, (2) it balances intuitive with deliberate reasoning, (3) it is structurally framed by doctrine, (4) it is multi-dimensional and multi-level, (5) it is collaborative, (6) it is dynamic, and (7) it is part of a larger mental process. From these references, one can derive a set of characteristics that frame the cognitive, social, and ecological dimensions of thinking associated with battalion visualization. Doctrinally, these characteristics generally apply to visualization in any type of operational situation. Hence, they serve to frame any analysis that might be undertaken to identify key training objectives.

Visualization is Purposeful

From the outset it is clear that the usage of the term "visualization" in Army doctrine implies the purposeful linkage of situation awareness and understanding with action-taking.

That is, one engages in visualization for the specific purpose of identifying actions that can be taken to influence the present situation and move it toward an intended objective or end state:[1]

> Battle command applies the leadership element of combat power. It is principally an art that employs skills developed by professional study, constant practice, and considered judgment. Commanders, assisted by the staff, visualize the operation, describe it in terms of intent and guidance, and direct the actions of subordinates within their intent (p. 5-1).

That statement implies that visualization is a purposeful activity, one undertaken in the context of (1) the given operational situation and environment and (2) the specific mission assigned to the commander. Thus, while the visualization process might address many different aspects of the operational environment, it is a mental activity concerned only with those elements of the operational environment perceived to be relevant to the accomplishment of the assigned mission. Such focusing is absolutely necessary in order to prevent the commander and his staff from being overwhelmed by the enormous volume of information potentially available from the modern information space within which they operate. What information is deemed "relevant" or "irrelevant" in this process of selective filtering and focusing, however, depends largely upon the experiential background of the commander and his supporting staff, i.e., it is not a process easily reduced to a *pro forma* template or set of analytical rules:

> Judgment provides the basis for the considered application of combat power in innovative ways adapted to new situations. In circumstances where experience provides few answers, commanders combine their experience, intuition, and judgment with the recommendations of the staff and subordinates to create new strategies (p. 5-13).

Visualization Balances Intuitive with Deliberate Reasoning

In describing the overall process of battle command as an art, Army doctrine infers that visualization is frequently an intuitive process—that is, one that gathers information largely by automatic cue recognition and the activation of tacit knowledge:

> Using judgment acquired from experience, training, study, and creative thinking, commanders visualize the situation and make decisions. In unclear situations, informed intuition may help commanders make effective decisions by bridging gaps in information. Through the art of command, commanders apply their values, attributes, skills, and actions to lead and motivate their Soldiers and units (p. 5-2).

Experience and intuition play a large role in traditional linear combat operations where a familiar battle calculus aids in the immediate recognition and interpretation of cues and information from the operational environment. By contrast, nonlinear and noncontiguous operations—e.g., modern stability, counterinsurgency, and nation-building operations—do not typically lend themselves to an intuitive visualization process unless the commander has acquired knowledge of their important elements through professional military education or

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[1] Except where indicated, all quotations in this section of the paper are taken from FM 3.0, *Operations*, dated June 2001, Department of the Army.

independent academic study. In such situations, the commander must rely more heavily on deliberate staff analysis, historical analogies, and the visualization of creative solutions.

> In circumstances where experience provides few answers, commanders combine their experience, intuition, and judgment with the recommendations of the staff and subordinates to create new strategies. In many instances, solutions to tough questions may come from the reasoned application of historical study, a hallmark of professional development. In other situations, small unit leaders or Soldiers invent solutions to tactical problems. When proposed solutions appear, commanders consider them and decide on appropriate actions (p. 5-13).

Visualization is Structurally Framed by Doctrine

The fact that intuition (i.e., tacit knowledge) plays an important role in framing the visualization process does not imply that commanders lack doctrinal guidance regarding key dimensions that constitute an effective vision. This is reflected in three ways. First, Army doctrine specifies that the elements of a commander's vision vary by echelon of command. Specifically, we see that:

> Commanders' perspective and the things they emphasize change with echelon. Operational art differs from tactics principally in the scope and scale of what commanders visualize, describe, and direct. Operational commanders identify the time, space, resources, purpose, and action of land operations and relate them to the joint force commander's (JFC) operational design. In contrast, tactical commanders begin with an area of operations (AO) designated, objectives identified, the purpose defined, forces assigned, sustainment allocated, and time available specified (p. 5-3).

Second, Army doctrine specifies a number of dimensions that have been traditionally considered to frame the commander's vision. These dimensions include Mission, Enemy, Terrain and weather, Troops and support available, Time available, and Civilians (METT-TC). While originally derived in the context of linear combat operations, these dimensions nevertheless remain important in the planning and execution of any military operation:

> To visualize the desired outcome, commanders must clearly understand the situation in the operational environment: What is the mission? What are the enemy's capabilities and likely actions? What are the characteristics of the AO? Do weather and terrain favor friendly or enemy actions? How much time is available? What combat service support (CSS) factors are most important? What role do civil considerations play? This framing of the operational environment takes place during mission analysis. Additionally, commanders draw on the principles of war, tenets of operations, and their experience (p. 5-3).

> METT-TC refers to factors that are fundamental to assessing and visualizing: Mission, Enemy, Terrain and weather, Troops and support available, Time available, and Civil considerations. The first five factors are not new. However, the nature of full spectrum operations requires commanders to assess the impact of nonmilitary factors on

operations. Because of this added complexity, civil considerations have been added to the familiar METT-T to form METT-TC. All commanders use METT-TC to start their visualization. Staff estimates may address individual elements of, and add to, the commander's visualization (p. 5-3).

Third, the planning of major operations doctrinally begins with a design—an idea that guides the framing, articulation, and synchronization of the operation. In today's contemporary operating environment (COE) it is important that battalion commanders consider some of the elements of an operational design in the draft FM 3-0, June 2001, include:

- End state and conditions.
- Center(s) of gravity.
- Operational approach.
- Decisive points.
- Defeat mechanism.
- Lines of operation.
- Operational reach.
- Simultaneous and depth.
- Tempo.
- Phasing & Transitions.
- Culminating point.
- Operational risk.

These elements are considered early in the planning process during the mission analysis phase to establish an operational framework that guides subsequent staff analyses, discussions, and decisions. However, this framework is subject to continual modification and refinement as either (1) more is learned about the operational environment or state of the operational environment or (2) the state of the operational environment evolves over time:

> Upon receipt of a mission, commanders consider their operational environment and conduct a mission analysis that results in their initial vision, which they continually confirm or modify. Commanders use the factors of METT-TC, elements of operational design, staff estimates, input from other commanders, and their experience and judgment to develop their vision (p. 5-3).

Again, emphasis is given in current Army doctrine to distinguishing which elements of operational design are traditionally focused on by operational versus tactical commanders:

> The elements of operational design are most useful in visualizing major operations. They help clarify and refine the vision of operational-level commanders by providing a framework to describe operations in terms of task and purpose. They help commanders understand the complex combinations of combat power involved. However, their usefulness and applicability diminishes at each lower echelon. For example, senior tactical commanders must translate the operational commander's operational reach and culminating point into a limit of advance for ground forces. Decisive points become geographic or force-oriented objectives. Senior tactical commanders normally consider

> end state, decisive points and objectives, culminating point, simultaneous and sequential operations, linear and nonlinear operations, and tempo. However, their subordinates at the lowest tactical echelons may only consider objectives (p. 5-6).

During this project, however, discussions with Army field grade officers with recent combat experience suggested that battalion level commanders must now adopt much of the same visualization framework once emphasized only for operational level commanders.

Visualization is Multidimensional and Multilevel

While Army doctrinal guidance might seem to clearly delineate what comprises a commander's vision at each echelon of command, the role of modern military forces in stability, counterinsurgency, and nation-building operations frequently blurs this distinction. For example, the recent coining of such phrases as the "*strategic corporal*" and "*strategic lieutenant*" suggests that tactical decisions and operations can have a potentially significant impact on the achievement of strategic end states and operational goals. Adding to this issue, increases in the lethality and precision of combat forces have resulted in tactical units being given responsibility for AOs equivalent in size to what operational units once had. Third, the nature of modern stability, counterinsurgency, and nation-building operations has placed increased emphasis on a host of additional operational environment dimensions—political, economic, social, and psychological (information)—that cannot be neatly partitioned by echelon of command. Fourth, such operations potentially involve a rapid shift between lethal and non-lethal operations and back again. This requirement is reflected in the recent coining of another phrase, "*three-block war*," in which troops might be decisively engaging an insurgent cell in one block, handling a civilian protest in another block, and engaging in a local reconstruction or humanitarian assistance project in a third block. And finally, the enduring nature of these operations—as opposed to the rapid and decisive defeat of traditional nation-state military forces on a linear battlefield—implies the need for even tactical commanders to simultaneously consider both short-term and long-term time horizons. In short, the scope and complexity of what a battalion commander must now consider in planning and executing his operations has increased dramatically in recent years. Failure to do to this is likely to lead to unintended consequences:

> Given the volatile and politically charged nature of most stability operations, individual and small unit actions can have consequences disproportionate to the level of command or amount of force involved. In some cases, tactical operations and individual actions can have strategic effects. Recognizing and avoiding potential problems requires trained, disciplined, and knowledgeable leaders and Soldiers at every level. Every Soldier must understand the operational and strategic context of the mission and the potential military, political, and legal consequences of their actions or inaction (p. 9-15).

> Stability operations occur in the public view. This includes continuous observation by host nation, domestic, and international populations as well as the media. Knowing this, opponents of stability efforts will seize on relatively minor incidents to achieve strategic advantages. Potentially, a single act of indiscipline or rash application of force can undo months and years of disciplined effort. Likewise, actions that are destructive to the

natural or cultural environment may introduce negative perceptions that must be overcome (p. 9-15).

Visualization is Collaborative

The scope and complexity of the commander's visualization process implies the need for collaboration in order to achieve unity of effort at both operational and tactical levels of command. Unity of effort includes the ability to identify, consider, and reconcile multiple points of view from either specific experts in a functional area or other stakeholders whose decisions and operations can potentially impact the commander's operational environment. At the same time, unity of effort serves to leverage limited resources across military units and agencies potentially contributing to the same set of objectives. Unity of effort across different time scales also serves to minimize or avoid unintended negative consequences that can compromise long-term goals and objectives. Relevant stakeholders can include, for example, U.S. or coalition military units adjacent to the commander's AO, host nation military forces operating in partnership with U.S. military units, other military or intelligence teams operating independently within the AO, U.S. State Department or other government agencies conducting reconstruction activities within the AO, and any number of international relief agencies conducting humanitarian operations within the AO.

> Subordinate, adjacent, and higher commanders use similar factors but different perspectives to visualize their operational environment. Commanders increase the depth and sophistication of their visualizations through exchanges with other commanders. Advanced information systems support this collaboration by allowing commanders to share a common operational picture (COP). In a similar fashion, staff input, in the form of estimates, provides focused analysis of the situation and its potential effects on operations. Commanders direct staffs to provide the information necessary to shape their vision (pp. 5-12, 5-13).
>
> Unity of effort requires constant coordination with all involved agencies. Stability operations require commanders to adapt to situations where lines of authority and areas of responsibility are unclear. This is important because the military is often the supporting rather than the supported agency. Commanders coordinate and integrate civilian and military activities. Likewise, commanders make their military objectives and operational schemes clear to other agencies. Coordination makes unity of effort and effective integration work in environments where unity of command is not possible. It also lends coherence to the activities of the elements involved (p. 9-14).

Visualization is Continuously Dynamic

Visualization is a continuous mental process –but one that is linked in a cyclical or iterative manner with action-taking. That is, the execution of operations within the commander's AO will often reveal further aspects of an adversary's forces or elements of the operational situation that can (1) alter the commander's visualization of the operational environment in key ways and (2) lead to the subsequent exploitation initiatives. Conversely, an asymmetric adversary or elements of civilian population can be unpredictable at times, placing new demands

and constraints on the commander's on-going operation. Accordingly, the commander must be prepared to continually assess the on-going operations in order to validate or revise his understanding of the operational environment.

> Assessment is the continuous monitoring—throughout planning, preparation, and execution—of the current situation and progress of an operation, and the evaluation of it against criteria of success to make decisions and adjustments. Commanders direct adjustments to ensure that operations remain aligned with the commander's intent... Assessment entails two distinct tasks: continuously monitoring the situation and the progress of the operation, and evaluating the operation against measures of effectiveness. Together, the two tasks compare reality to expectations (p. 6-22).

Ultimately, only successes that achieve the end state count. To determine how to exploit tactical and operational successes, commanders assess them in terms of the higher commander's intent. An operational design links objectives along lines of operations. However, success will likely occur in ways unanticipated in the plan. Commanders may gain an objective in an unexpected way. Success signals a rapid assessment to answer these questions:

- Does the success generate opportunities that more easily accomplish the objectives?
- Does it suggest other lines of operations?
- Does it cause commanders to change their overall intent?
- Should the force transition to a sequel?
- Should the force accelerate the phasing of the operation?

> Operationally, success may signal a transition to the next phase of the campaign or major operation. Ideally, an appropriate sequel is ready. However, even a prepared sequel requires rapid refinement to reflect the realities of the actual success. Commanders see beyond the requirements of the moment. They employ every available asset to extend their operations in time and space to make the success permanent. Commanders understand that they must maintain momentum and initiative to win rapidly and decisively (p. 6-12).

Visualization is Part of a Larger Mental Process

While visualization is continuously dynamic, it is also framed by the Army's traditional Military Decision-making Process (MDMP). This process logically sequences the mental task flow required to translate high-level vision and intent into specific operational orders. Given the continuous and dynamic nature of most military operations, the MDMP is usually repeated—or revised—over time to adjust operations to the commander's evolving understanding of the operational environment. The MDMP nominally consists of a set of planning tasks sequentially carried out by the commander and his staff after they receive a mission order from their higher command:

- Mission Analysis.
- Course of Action Development.
- Course of Action Analysis and Approval.

- Orders Production.
- Rehearsal.
- Execution and Assessment.

While the exact manner of executing these tasks can vary in terms of both time and detail, their logical sequencing reflects an ordered decomposition of the commander's visualization into actionable directives. Doctrinally, visualization is a continuous process that a commander, along with input from staff, use from the receipt of mission to end state/mission accomplishment. The visualization process comprises a complete task sequence that mentally translates understanding into action:

- *Visualize* the operational environment in terms of the assigned mission, the adversary's capabilities and likely actions, and the characteristics of the AO. The visualization phase is framed by the METT-TC factors and the elements of operational design that each constitutes an important component of the commander's understanding of the operational environment. Visualization is emphasized within the mission analysis task.
- *Describe* the intended operation in terms time, space, resources, purpose, and actions. The description phase articulates the commander's intent and translates the elements of operational design into a cohesive set of decisive, shaping, and sustaining operations over time and space. Description is emphasized within the course of action development, analysis, and approval tasks.
- *Direct* the different warfighting functions—intelligence collection and analysis; maneuver forces; lethal and non-lethal fire support; air defenses; mobility, counter-mobility, and survivability operations; combat service support; and command and control—to carry out specific, synchronized actions within a coherent and focused intent. Direction is emphasized within the orders production, rehearsal, execution, and assessment tasks.

Current Army doctrine tends to emphasize a shift of emphasis regarding the importance of each of these task areas as one moves from the operational level of command to the tactical level of command:

> Visualizing, describing, and directing are aspects of leadership common to all commanders. Technology, the fluid nature of operations, and the volume of information increase the importance of commanders being able to visualize and describe operations. Commanders' perspective and the things they emphasize change with echelon. Operational art differs from tactics principally in the scope and scale of what commanders visualize, describe, and direct. Operational commanders identify the time, space, resources, purpose, and action of land operations and relate them to the JFC operational design. In contrast, tactical commanders begin with an area of operations (AO) designated, objectives identified, the purpose defined, forces assigned, sustainment allocated, and time available specified.
>
> While JFCs and component commanders exercise leadership primarily through subordinates, small unit commanders command face to face. Operational success depends on the ability of operational commanders to visualize and describe complex land

operations; tactical success depends on the ability of small unit commanders to motivate and direct Soldiers.

Commanders use the factors of METT-TC to assess the situation. Staff estimates and collaborative information sharing among commanders refine and deepen their situational understanding. Commanders then visualize the operation, describe it within their intent, and direct their subordinates toward mission accomplishment. Depending on echelon, commanders examine the elements of operational design and determine factors that will shape the operation. Commanders direct operations and synchronize the [warfighting functions] through plans and orders. They personally apply the leadership element of combat power through their presence and priorities (pp. 5-2, 5-3).

While much of this guidance remains true under any set of operational circumstances, the nature of modern stability, counterinsurgency, and nation-building operations suggests that visualization and description remain an important task area for tactical commanders at even small unit level.

Summary of Characteristics

From the above discussion, it is possible to identify from Army doctrinal literature several characteristics of visualization that can serve as a guide for identifying and articulating important visualization skills at different tactical levels of command. These characteristics, depicted in Figure 1, include:

- Visualization purposefully frames actions and links them with understanding and intent—it serves to specifically frame and identify actions that can be taken to move the state of the operational environment toward a set of objectives, goals, or desired end states.
- Visualization is synchronized vertically across the commander and staff who each contribute to its construction and maintenance.
- Visualization balances intuition with deliberate reasoning according to the degree to which the current situation matches the experience of the commander.
- Visualization is structurally framed by Army doctrine to provide a common ground of understanding—e.g., METT-TC, elements of operational design—that specify the common understood elements of knowledge that traditionally comprise an effective operational plan.
- Visualization is matched to the dimensions of levels of operational complexity faced in modern military operations—e.g., short-term security operations (military) versus long-term nation-building and counterinsurgency operations (political, economic, social, information).
- Visualization is collaborative constructed in order to achieve unity of effort across the multitude of units, teams, and agencies that can potentially impact the commander's operational environment.
- Visualization is continuously adjusted in response to both aspects of the operational environment revealed by a military unit's actions and the often unpredictable nature of asymmetric adversaries and civilian populations.

- Visualization supports and guides a larger planning and execution process that combines visualization, description, and direction in order to translate understanding into action.

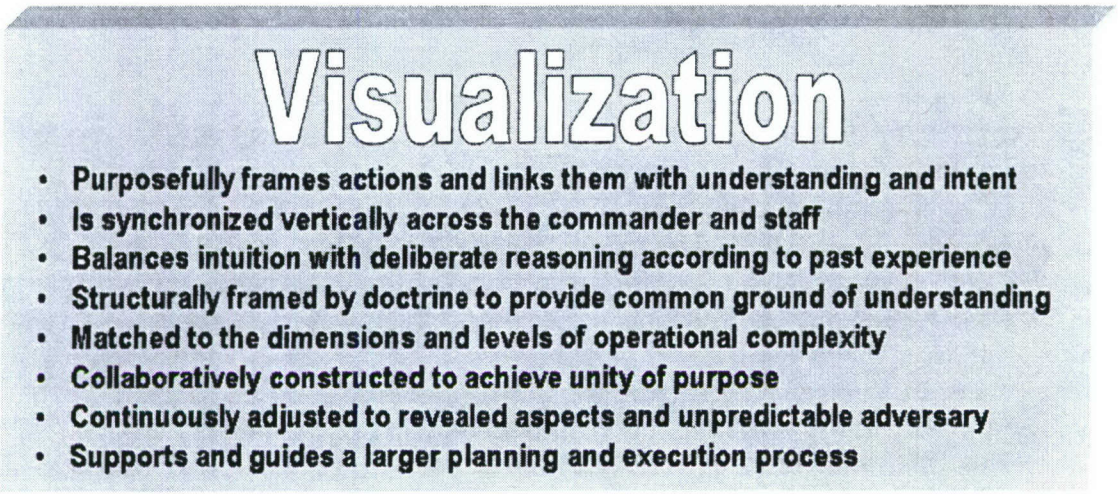

Figure 1. Visualization Characteristics.

Taken together, these eight characteristics of visualization—purposeful, synchronized, balancing intuition with deliberate reasoning, structurally framed, multifaceted and multilevel, collaborative, continuously dynamics, and part of a larger mental process—provide a basic framework for examining how visualization skills might be improved through training. However, these characteristics are only general in nature and do not yet convey the complex challenges of visualization faced by tactical commanders in Afghanistan, Iraq, or other recent operations. To begin to understand these challenges at a deeper level, we must now turn attention to the specifics of modern stability, counterinsurgency, and nation-building operations.

Adapting the Visualization Process to Stability Operations

In order to provide a more focused context for examining visualization skill requirements, it is useful to briefly review the types of operations currently encountered by battalion level commanders and staff and to highlight the manner in which they significantly differ from traditional linear combat operations. Such operations are not new; however, they represent a significant departure from the types of operations traditionally emphasized during the Cold War period. This discussion begins with a general review of stability operations and then delves more deeply into two aspects of these operations that present a specific visualization challenge for the tactical commander–counterinsurgency operations and nation-building operations.

Stability Operations Defined

According to FM 3.0, stability operations are designed to promote and protect U.S. national interests by "influencing the threat, political, and information dimensions of the operational environment" (Department of the Army, 2001a). Doctrinally, stability operations encompass a range of activities, including:

- Peacekeeping and peace enforcement operations conducted in support of diplomatic efforts,
- Foreign internal defense operations—indirect/direct support and combat operations—designed to free and protect another government and its society from subversion, lawlessness, and insurgency,
- Security assistance programs that provide defense resources, military training, and services to a foreign nation,
- Humanitarian and civic assistance designed to provide basic care and restore public infrastructure for a specific population,
- Support to insurgency movements that oppose regimes threatening U.S. interests or regional stability,
- Support to counter-drug operations conducted by other U.S. government agencies within a specific region,
- Counterterrorism (offensive) and antiterrorism (defensive) operations that are targeted against specific terrorist organizations and facilities operating in a region outside the U.S. and its territories,
- Noncombatant evacuation operations designed to remove civilians from the threat of hostilities or natural disasters,
- Arms control operations focused on the identification and control of weapons of mass destruction and/or enforcement of arms control treaties, and
- Show of force operations conducted to bolster allies, deter potential aggressors, and gain influence within a specific region.

While each of these mission types reflect a unique focus or purpose, they are often undertaken in an overlapping manner to further U.S. national interests in a given region. In practical terms, they often constitute different lines of operation within an overall operational campaign. Actions taken to achieve objectives along one line of operation might very well further the achievement of objectives associated with another line of operation. Conversely, actions that effectively support one line of operation might produce unintended consequences that interfere with progress along another line of operation. Therefore, it is important for the commander to be able to visualize important areas of reinforcement or conflict among the different lines of operation and to carefully describe intended synergies and constraints in his course of action guidance to subordinates.

Planning and conducting stability operations rely upon the same general skill sets and processes required for traditional offensive and defensive operations—e.g., the visualize-describe-direct process, MDMP, and troop leading process. At the same time, it is important for the commander to understand important aspects of stability operations that distinguish them from more traditional offensive and defensive operation. Characteristics emphasized in Army doctrine include the following:

> Stability operations are normally nonlinear and often conducted in noncontiguous areas of operations (AOs). They are often time and manpower intensive. Commanders analyze each mission and adapt the operational framework, elements of operational design, and factors of METT-TC to fit the situation. They often use logical lines of operation to visualize an operation and describe it in terms of decisive, shaping, and

sustaining operations. However, determining the military actions necessary to achieve the desired political end state can be more challenging than in situations requiring offensive and defensive operations; achieving the end state may be just as difficult (pp. 9-4, 9-5).

Stability operations often require commanders to apply METT-TC differently than they would when conducting offensive and defensive operations. The "enemy," for example, may be a set of ambiguous threats and potential adversaries. Even the mission may change as the situation becomes less or more stable. A mission can be as simple as conducting a briefing to host nation forces in a military-to-military exchange or as difficult as conducting combat operations to accomplish a peace enforcement mission (p. 9-5).

Different factors may be important when analyzing the terrain and the troops and support available in stability operations. What constitutes key terrain may be based more on political and social considerations than physical features of the landscape. The troops assigned or available to a commander could include nontraditional assets, such as host nation police units, contracted interpreters and laborers, or multinational forces. The level of integration and cohesion of a force composed of diverse assets is a key consideration for mission success (p. 9-5).

The goals of a stability operation may not be achievable in the short term. Success often requires perseverance, a long-term commitment to solving the real problem. The achievement of these goals may take years. Conversely, daily operations may require rapid responses to changing conditions based on unanticipated localized conflict among competing groups. Civil considerations are especially critical in stability operations. The civil population, host nation government, nongovernmental organizations (NGO), and international organizations can greatly affect achieving stability (p. 9-5).

Small unit leaders are required to develop interpersonal skills—such as cultural awareness, negotiating techniques, and critical language phrases—while maintaining warfighting skills. They must also remain calm and exercise good judgment under considerable pressure. Soldiers and units at every level must be flexible and adaptive. Often, stability operations require leaders with the mental and physical agility to shift from non-combat to combat operations and back again (p. 9-5).

Stability operations help restore law and order in unstable areas outside of the U.S. and its territories. However, the mere presence of Army forces does not guarantee stability. Offensive and defensive operations may be necessary to defeat enemies that oppose a stability operation. The ability of Army forces to stabilize a crisis is directly related to their perceived ability to attack and defend as necessary (p. 9-5).

These characteristics suggest the need for commanders to consider a number of factors in their planning and execution of stability operations. In turn, these factors—identified either in FM 3.0 or in joint doctrine (U.S. Joint Forces Command, 2004) shape the commander's visualization process. The following discussion summarizes each of these doctrinal

considerations and then highlights relevant points to consider from a battalion visualization perspective.

Leverage Interagency, Joint, and Multinational Cooperation

Stability operations frequently involve multiple entities and stakeholders conducting independent operations within the same AO. Unity of effort requires commanders at all levels to adapt their thinking process in situations where lines of authority and areas of responsibility are unclear and where the military is often in a supporting—rather than supported—role. Coordination with other agencies and operations—often facilitated by personal relationships—is absolutely essential to achieving unity of effort when unity of command is not possible. From a visualization perspective, this places importance on building shared understanding of the operational environment affecting each agency or unit (METT-TC), a shared understanding of each agency's or unit's intent (elements of operational design), and a shared understanding of how each agency's or unit's resources and operations can be effectively leveraged. Without unity of command, development of shared understanding will likely be a collaborative (i.e., a negotiated) process that considers the perspectives of each stakeholder.

Enhance the Capabilities and Legitimacy of the Host Nation

Underlying the objectives of stability operations is the need to build and support the capabilities and legitimacy of the host nation, frequently considered to be a center of gravity within the overall military campaign. Achievement of this goal requires the commander to further adapt his thinking process to emphasize the role and accomplishments of the host nation—rather than that of his own forces. Such a shift in thinking will likely run counter to a long-held confidence in his own unit and a desire for rapid and efficient accomplishment of tactical objectives. Resources might be "taken out of hide" to support the training of host nation military and police units. Tactical operations will be conducted with less speed and precision when host nation forces are integrated with U.S. forces, as compared with U.S. only operations. But ultimately, it is the host nation—not U.S. forces supporting it—that must be seen to win and maintain control of the operational situation. From a visualization perspective, this requires the commander to incorporate host nation capabilities and operations into both his framing of the operational environment (METT-TC) and his translation of intent into action (elements of operational design).

Understand the Potential for Unintended Consequences

The volatile and politically charged nature of the operational environment associated with stability operations implies that individual and small unit actions can create unintended negative consequences disproportionate to the level of command or amount of forces involved. At the same time, stability operations occur in full view of the public and press. Commanders will have at their disposal more combat power than is often needed or prudent to apply in a given tactical situation, and a single act of indiscipline or rash application of this combat power can undo a civilian population's level of trust and cooperation that has taken months or years to build. From a battalion visualization perspective, this elevates the importance of the "civilian" element of METT-TC—thus requiring the commander to consider civilians as a center of gravity, rather than merely as a shaping factor for combat operations. Visualizing a civilian population as the

"objective" within an operation reflects a paradigm shift from the more traditional type of mental model—e.g., "capture terrain" or "attrite enemy forces"—associated with offensive and defensive operations. It also requires the commander to conceptualize the operational environment in terms of its Area, Structures, Capabilities, Organizations, People and Events (ASCOPE) (Department of the Army, 2003).

Display the Capability to Use Force in a Non-Threatening Manner

Units must be prepared to demonstrate combat power for self-defense, yet do this in a way that is non-threatening and avoids provoking an unintended consequence. Maintaining this delicate balance under conditions of "the three block war" is a challenge–in terms of both precisely defining and judiciously applying rules-of-engagement (ROE) and maintaining a unit's level of aggressiveness versus constraint. From a visualization perspective, the commander must envision the dual potential for combat power to reflect either a threat (to adversaries) or a sense of security (for the civilian population). Extending this notion further, the commander must be able to visualize each of his available resources or capabilities in terms of their potential to provide for a civilian population's ordered hierarchy of needs.

Act Decisively to Prevent Escalation/Apply Force Selectively and Discriminately

These last two doctrinal considerations are considered together since they reflect opposing ideas and underscore the need for operational balance. Adversaries can perceive hesitation as weakness and be emboldened to escalate instability if a commander fails to act with speed and determination. Being overly cautious can also damage the confidence of uncommitted civilian populations. At the same time, decisive engagement does not imply that a unit can act with belligerence. Commanders must apply force in a manner consistent with their objectives. The application of force must be calculated to achieve the specific objectives of a stability operation—e.g., end a crisis, restore public confidence, deter future confrontations.

The increased complexity and ambiguity of stability operations—as compared with linear offensive and defensive operations—often makes such force application calculations and tradeoffs more difficult. From a visualization perspective, this requires the commander to continuously assess the need for different types of visualization strategies and actions.[2] As will be discussed in more detail later in this paper, some events might reflect a known or knowable type of situation—that is, one in which a familiar set of tactics, techniques, and procedures (TTP) can be applied to efficiently achieve a limited mission objective (e.g., a cordon and search against a suspected terrorist safe house). Here, the commander's visualization process is framed by the familiar TTPs, with emphasis given to developing actionable intelligence required by the mission. In a second case, events might reflect a complex or novel situation where the commander's visualization process is focused more on detecting and interpreting meaningful patterns or linkages. Once identified, actions can then be focused to exploit these patterns or linkages (e.g., providing local employment opportunities to improve a neighborhood

[2] The notion that different visualization strategies are demanded by different types of problem situations is motivated by an interpretation of the work of Kurtz and Snowden (2003) at IBM's Cynefin Center. Their framework classifies different situations in terms of known, knowable, complex, and chaotic. Each type of situation suggests different strategies for developing understanding and order.

infrastructure, gain influence with local power brokers, and provide an economic alternative to those formerly willing to work for an insurgency group). In a third case, the level of chaos in a given situation might preclude the commander's ability to detect meaningful patterns or to focus on long-term objectives. At this point, the immediate and decisive application of force might be necessary to merely stabilize the situation to the point where further understanding can be developed.

The need to act in a discriminate manner is reinforced by the presence of different civilian groups within the commander's AO. This point is reinforced in joint doctrine through the recognition of different classes of threats to the stability process.[3] The presence and actions of these different groups add to the complexity to the commander's visualization.

Distinguish among Different Classes of Stability Spoilers

Stability operations, unlike linear combat operations focused against an organized and unified military force, require the commander to distinguish among a broad range of civilian actors that can potentially obstruct operations within his AO. Each of these actor groups represent different sets of interests and motivations; hence, the commander must uniquely visualize and respond to each civilian group in an appropriate manner. Failure to recognize these differences are likely to produce decisions and actions that increase further opposition to U.S. and coalition operations. Roughly speaking, these groups can be classified into the following categories: total spoilers, limited spoilers, and greedy spoilers (Stedman, 2000).

Total spoilers include those professional revolutionaries, ideologues, or deposed regime members who have no stake in reestablishing civil society, and are irreconcilably opposed to U.S. or coalition interests. In Iraq, for example, total spoilers are represented by such groups as "foreign terrorists" and "anti-Iraqi forces." Consequently, they are unwilling or unable to negotiate or be influenced by inducement and socialization programs. For these actors, the commander must visualize how best to isolate them from the rest of the civilian population and militarily defeat them in an efficient manner.

Limited spoilers are those actors associated with particular groups that possess feelings of superiority or endangerment—e.g., clans, tribes, religious sects—and who desire to settle the conflict on their terms of governance. They usually have a limited, and often valid, set of goals such as gaining legitimacy or a significant role in the political or administrative process of restoring the society. In Iraq, for example, limited spoilers are represented by such groups as "local freedom fighters" belonging to a particular tribe or clan and "private militias" offering their allegiance to a specific Sunni, Shi'ite, or Kurdish sect. For these actors, the commander faces a two-fold visualization challenge. First, he must visualize within an immediate time horizon the specific mechanisms and actions through which specific groups might be influenced to support U.S. or coalition interests. This will involve careful devotion of attention to the collection and interpretation of cultural and social intelligence, as well as careful planning of negotiations conducted with these groups. Second, he must visualize over an extended time

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[3] See U.S. Joint Forces Command. (2004). Security, Transition, and Reconstruction Operations Joint Operating Concept. Draft Version 1.06, dated 8 June 2004, for a more detailed discussion of stability operations spoilers.

horizon the longer-term consequences of each demand or concession as they affect the future political or social status of each group.

Greedy spoilers are those groups or individuals acting out of selfish, usually economic, interests—including criminals, black marketers, and even ordinary citizens attempting to provide support for their families. In Iraq, for example, greedy spoilers are considered to include hard-core criminals freed by the former regime, common citizens who consider the corruption just a normal way of life, and those unemployed individuals who are willing to commit acts of terrorism in return for economic payment. Such actors are not usually motivated by political or religious issue; rather, they see their activities as a means of personal survival. For these actors, the commander must visualize how the combined use of co-option (e.g., employment and other economic incentives) and standard police methods can be employed to remove this type of obstacle to the stabilization process.

The above classification of spoilers is considered general in nature and is not intended to imply a complete separation of one group from another. At times, total and limited spoilers will form temporary alliances when it is perceived to be in their mutual interests. Likewise, greedy spoilers will support the interests of total and limited spoilers when it serves their immediate self-interest. The interaction of these groups over time and space further increases the complexity of the commander's visualization process. At the heart of this challenge is the ability to visualize patterns of individual, social, political, cultural, and religious interests and their potential interaction across the operational environment. As compared with traditional linear combat operations, this type of environment requires the commander to focus on the identification and articulation (visualization) of non-lethal actions and causal pathways.

Selectively Employ Different Forms of Lethal and Non-lethal Influence

Each type of stability spoiler operating within the commander's AO requires a different strategy to dislocate, contain, or co-opt them. A singular approach is likely to encourage additional spoilers and demands. Accordingly, an effective stability and counter-insurgency campaign requires the commander to visualize an orchestrated system of coercion, inducements, and socialization.

Coercion. Coercion can range from total isolation or defeat of the spoiler (e.g., raids and cordon and search operations to detain high priority suspects), to the freezing or elimination of insurgency resources (e.g., cache searches, detention of local financiers, traffic control points), to the selective withholding of economic aid (e.g., withholding infrastructure repairs and improvements, the selectively barring the employment of specific groups). Commanders must always develop and maintain a clear understanding of why coercive actions are being employed and what they will achieve with each type of spoiler. For example, dominance of force or the threat of force will be used to destroy or isolate total spoiler groups from the rest of the population. Other types of coercive actions will be used to intimidate or restrict the movement of limited and greedy spoilers. Offensive operations include overt, covert, and clandestine missions. Defensive operations protect key personnel, facilities, and infrastructure from attack by spoilers. The use of coercive actions can be potentially misinterpreted by affected civilian populations, or they might inadvertently create a hardship on another segment of the population.

Therefore, the commander's visualization process must anticipate the need for consequence management: (1) follow-up reparation (e.g., compensation for damage done to personal residences) or other activities that serve to restore good will with the general population and (2) concurrent information operations (e.g., media campaigns that clearly explain the purpose of each coercive action) that serve to reduce popular support for the spoilers.

Inducements usually take the form of social support, economic payments, or other concessions offered to modify and convert limited spoilers. They can also be used to generate support within the general population for U.S. and coalition objectives. Inducements directly aimed at specific limited spoiler groups include providing area security for specific cities or neighborhoods, channeling employment opportunities for local projects and services through a specific leader or group, improving quality of life through infrastructure repair and improvement, and other activities so long as they are consistent with U.S. and coalition security, transition, and reconstruction objectives. Indirectly, these same types of inducements can serve to win the support of the general population (e.g., increase the recruitment of individuals as informants against the insurgents, reduce a city's or neighborhood's tolerance for harboring various spoiler groups). Use of inducements places special emphasis on the need for the commander to visualize immediate, long-term, and indirect consequences of each action. The commander must insure that the target audience of each inducement action clearly understands the implied quid pro quo via either a carefully planned negotiation session or media campaign—e.g., a neighborhood's electric power is being restored in exchange for a reduction in local improvised explosive device (IED) attacks—otherwise, the value of the inducement is lost. Conversely, the commander must understand how immediate actions and initiatives achieve unity of purpose by supporting long-term stability objectives—a requirement that links back to the notion that small unit actions can have consequences disproportionate to the level of command or amount of force involved (discussed earlier). Finally, as in the case of coercive actions, the commander must visualize how inducements can generate second and third-order effects within the operational environment. For example, providing economic or humanitarian aid to one sect might create an unwanted level of hostility in another sect that perceives they have been intentionally slighted.

Taking these ideas together, the commander's orchestration and selective targeting of both coercion and inducement actions against specific spoiler groups must be built upon a foundational understanding of the political, military, economic, social, information, and infrastructure dimensions of the operational environment. Visualization of potential short-term, long-term, and indirect consequences across these various dimensions will insure that actions maintain unity of purpose.

Organize Mission along Logical Lines of Operation

The Department of the Army defines a line of operation as "the orientation of the force in space and time, or purpose in relation to an enemy or objective" (Department of the Army, 2006a). Physical lines of operation—defined in terms of a geographic area or direction—are more common in traditional linear combat operations. In stability operations, however, positional reference to an adversary or civilian population often has little relevance. In such a case, the commander will more likely organize his force along logical lines of operation that

consider less tangible aspects of civil security, civil control, and civil action. According to FMI 5-0.1:

> Operations designed using logical lines of operations typically consist of an extended, event-driven time line. This time line combines the complementary, long-range effects of civil-military operations as well as the cyclic, short-range events characteristic of combat operations (p. A-7).

In many cases, the commander might combine both physical and logical lines of operation, depending upon the METT-TC factors. An example of combining a set of logical lines of operation with a geographic objective area is depicted in Figure 2 (Department of the Army, 2006a).

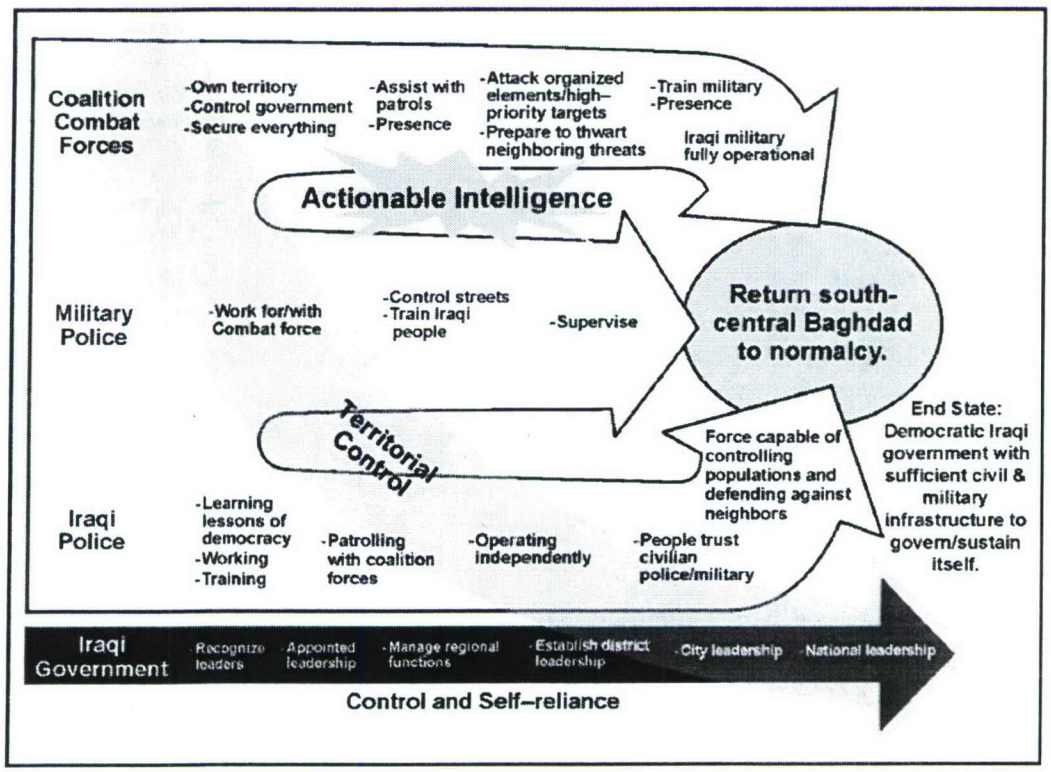

Figure 2. Examples of Logical Lines of Operation.

Summary of Visualization Requirements

As noted above, stability operations—unlike traditional linear combat operations—place emphasis on specific visualization requirements. Given the complex and asymmetric nature of stability operations, these requirements apply to both operational and tactical levels of command. These requirements, summarized in Figure 3, provide even further focusing for the development of future training in this area.

STABILITY OPERATIONS PRINCIPLE	BATTALION VISUALIZATION REQUIREMENTS
Leverage interagency, joint, and multinational cooperation	Commander must build shared understanding of environment as it affects each agency or unit, shared understanding of each agency's/unit's intent, and shared understanding of how resources/operations can be effectively leveraged.
Enhance capabilities and legitimacy of the host nation	Commander's operational framing and translation of intent into action must clearly define how host nation forces—not US forces—will win and maintain control of the battlespace.
Understand the potential for unintended consequences	Commander must visualize the civilian population as a center of gravity and conceptualize the battlespace in terms of its political, military, economic, social, information, and infrastructure dimensions.
Display the capability to use force in a non-threatening manner	Commander's understanding must clearly define how his available resources and capabilities can provide for a civilian population's ordered hierarchy of physiological, security, social, and self-actualization needs.
Act decisively / Apply force selectively and discriminately	Commander must adjust his specific visualization strategies and actions to different levels of ambiguity, complexity, and chaos in order to maintain confidence of civilian population while avoiding unnecessary belligerence.
Distinguish among different classes of stability spoilers	Commander's understanding must distinguish among total, limited, and greedy spoilers in terms of their different motivations, pathways of influence, and relevant time-lines of actions and consequences.
Selectively employ different forms of lethal and non-lethal influence	Commander's orchestration and selective targeting of coercion and inducement must be built on a foundational understanding of the political, military, economic, social, information, and infrastructure dimensions of the battlespace.

Figure 3. Battalion Visualization Requirements Emphasized in Stability Operations.

Visualization: A Psychological Perspective

The discussion turns next to a consideration of visualization from a psychological perspective. This perspective will provide both a basis for understanding the real-world experience of U.S. Army officers recently returned from Afghanistan and Iraq (discussed later in this report) and a framework for guiding the incorporation of specific pedagogical strategies in future training development.

Visualization as a Continuous Process

An important aspect of life is about making sense of the world we live and operate in, and then acting within that framework of understanding to achieve desired goals and objectives. Hence, another term for visualization is *sense-making*.[4] We engage in sense-making at the individual level and, in collaboration with others, at the organizational level to (1) organize our search for and interpretation of useful information, (2) to place that information within a meaningful context defined by our experience and expertise, and (3) to shape our decisions and actions within a cognitive and social framework that is relevant to our perceived interests and objectives. On the surface, it would seem like sense-making ought to be a relatively straightforward process or activity. Yet, as illustrated by the previous discussion of stability

[4] In this section of the report, the terms "visualization" and "sense-making" are used interchangeably inasmuch as they both refer to the process of developing and maintaining a framework of understanding within which decisions and actions can be taken in a purposeful manner.

operations, it is not always easy for either individuals or organizations to make coherent sense of their environment—or to act in a productive manner.

But what exactly is meant by the terms visualization or sense-making? What is considered to be part of these processes? And, from a systems engineering perspective, what elements need to be addressed in a study of these processes?[5] One way to begin defining the process of visualization (or sense-making) is to compare it with decision-making, an activity that is familiar to most people. Making decisions or planning actions in the real world is rarely an easy task—unlike the study of decision-making in a laboratory setting where problems are predefined, critical variables are identified, and choices are obvious to everyone involved. In fact, the major challenge often faced by most individuals and organizations is neither information gathering nor decision-making. Rather, it is engaging successfully in what might be termed the predecisional activity of structuring available information and experience so as to properly frame the decision-making process. At the same time, individuals and organizations initiate actions to either shape their work environment or probe it in order to develop greater understanding. Thus, it is important to consider the relationship that exists between visualization (or sense-making) and action taking.

As shown in Figure 4, individuals within a large-scale system draw information from what might be termed an information environment—typically not the actual physical work domain, but an approximate, symbolic representation of it. Exactly what information is drawn from this environment and how this information is interpreted is a matter of individual expertise, motivation, and perspective. For example, each of the three persons illustrated at the left of this figure might focus on different aspects of an operational situation. Each person is also likely to form different interpretations of the situation, depending upon their unique experience, their unique organizational interests, and their unique roles and responsibilities within the overall system. If they are to cooperatively act in some cohesive manner, these individuals might come together in what some have termed a community of interest—a collaborative forum that holds a common interest in the operational work domain. The purpose of this collaboration is simple, to reconcile the multiple perspectives into a shared and cohesive framework for making decisions and taking action.

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[5] The discussion of the visualization presented in this section of the report is based upon the accumulated research on organizational sense-making (c.f., Weick, 1995; Weick, & Sutcliffe, 2001; Choo, 1998; Klein, Phillips, Rall, & Peluso (In Preparation), and Nonaka, & Takeuchi 1995.)

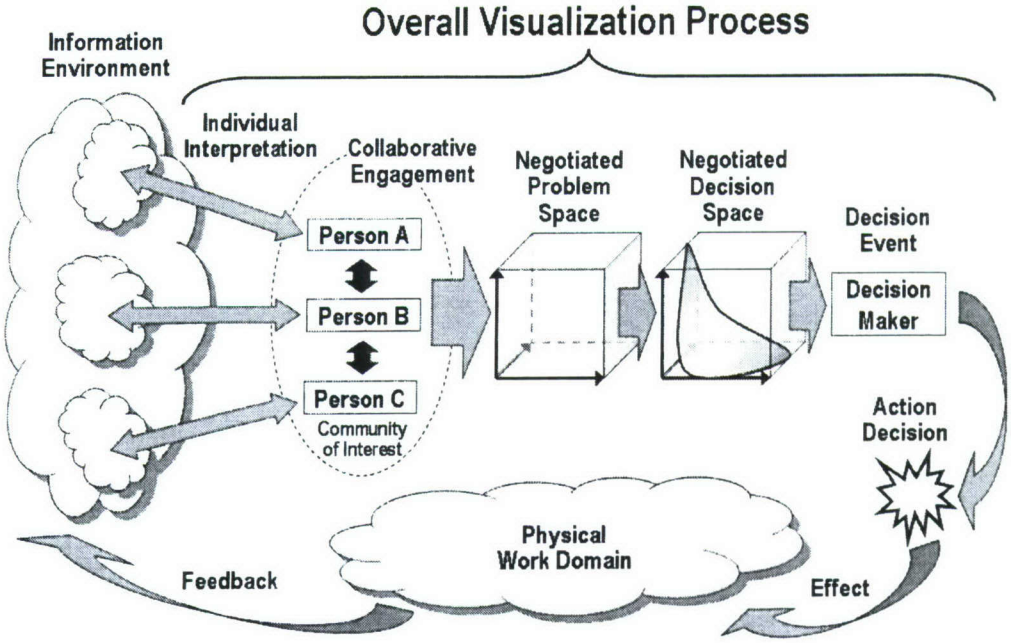

Figure 4. The Process of Sense-making (Visualization).

While some researchers have generally termed the product of this collaboration to be a "shared understanding," it is useful at this point to define this term more specifically. As depicted in the figure, the first product of this collaborative undertaking is a negotiated problem space—that is, an agreement among the individuals as to what constitutes a valid set of work goals, a set of relevant constraints, a list of key state variables and processes of interest, and a set of paradigms that describes how these variables and processes interact with one another. Details of this negotiated problem space are likely to be an amalgamation of the individual perspectives, depending upon the manner in which these individuals interact—e.g., one individual might exert more influence because of formal or informal authority within the community of interest. A second product emerging from this collaborative undertaking is a negotiated decision space, a subset of preferable solution states that correspond to decision choices which are available to the system. Again, the details of this negotiated decision space are likely to be an amalgamation of the means-ends paths envisioned by the different individuals. Together, these spaces provide the framework within which the decision-maker—perhaps, one of the individuals—can engage in either recognition-primed decision-making or more formal choice evaluation. The actual decision event (shown at the right of Figure 4) produces some type of action that has an effect on the physical work domain. This effect, in turn, is likely to change the state of the work environment in some way, resulting in informational feedback to one or more of the individuals. The cyclic nature of the process depicted here suggests that systems engage in a continuous process of information collection, individual interpretation, collaborative framing, decision-making, and action-taking in order to move the system toward a desired set of goals within the physical work domain.

Using the illustration in Figure 4, it is now possible to begin talking about visualization as a systems process. That is, visualization involves almost every activity outlined in Figure 4. One element of visualization includes the predecisional activities of individual information

collection and interpretation—activities that are largely cognitive in nature. At the same time, another important element of visualization is the collaborative framing of the problem space and decision space—necessitated by the fact that large-scale systems typically involve multiple stakeholders and experts who can look at the work domain from different perspectives. Because visualization at the organizational level involves various types of collaboration, it depends upon the social and organizational structure of the system. Finally, visualization also involves taking action—either to move the state of the work domain closer to a desired set of goals, or to reveal further insight about the work domain that can be subsequently exploited for advantage.

Levels of Analysis and Intervention

As suggested by the foregoing discussion, it is useful to look at this process from three different levels of analysis: (1) the internal mental processes of the individual that create actionable knowledge in the context of a specific, goal-driven work domain, (2) the social or organizational context in which multiple individuals and stakeholders collaborate to negotiate and form shared beliefs and to develop cohesive actions, and (3) the ecological level at which the visualization process of the individual or organization interacts with the work domain to monitor and adjust both thinking and actions.

Cognitive Level of Analysis

At its core, visualization is primarily a cognitive process that occurs within the individual. As shown in Figure 5, visualization involves the selective retrieval of data elements from the information environment, the activation of relevant tacit knowledge framework or mental models from the individual's experience, and the mental integration of these data and frameworks to form focal knowledge (Polanyi, 1962). Focal knowledge represents the "current understanding" of the problem space in terms of high-level objectives and their decomposition into specific actions. Focal knowledge represents the framework within which the individual commits to specific actions. Here, focal knowledge is depicted as an organized and activated set of mental concepts that extend from the abstract down to the concrete. Their specific state of activation defines the manner in which they are logically linked by the individual to form an overall understanding or mental model of the operational situation. This same idea was been expressed in military terms by Major General Russell Honoré (2002):

> The commander must visualize each operation from the current state along a line of operations to the end state. Through the application of the art of war, the commander gets a picture of the operation in his mind. Intuition, based on experience and education, feeds the art of this process. But, just as a painter must know the primary colors and the combinations that produce complementary colors in order to create a masterpiece, the commander must know the science of war and demonstrate mastery of it. The science of war provides the basis for logic and understanding of his visualization. The commander uses the battlefield framework to form the visualization. The assigned area of operations delineates the physical volume of space in which the formation will operate. The operational environment is conceptual and includes such things as the area of influence, the area of interest, the information sphere, the flow of reinforcements, institutional capabilities, and so on. Another aid in forming the visualization is METT-TC, the factors

of which aid in understanding how the mission relates to the situation in time, space, resources, and purpose.

Resources available vary based on the level of the organization, but they can be described by the elements of combat power (leadership, maneuver, firepower, protection, and information) and the [warfighting functions]. For the purpose of visualization, the specific tasks to the formation might not be fully developed, but the overall aim and the purpose of the operation must become clear. In the lexicon of operations doctrine, purpose-based operations facilitate the visualization by establishing early on what is decisive, which shaping operations support the decisive operation, and which sustaining operations facilitate the decisive and shaping operations. These purpose-based operations communicate purpose in spite of physical geometry (p. 13).

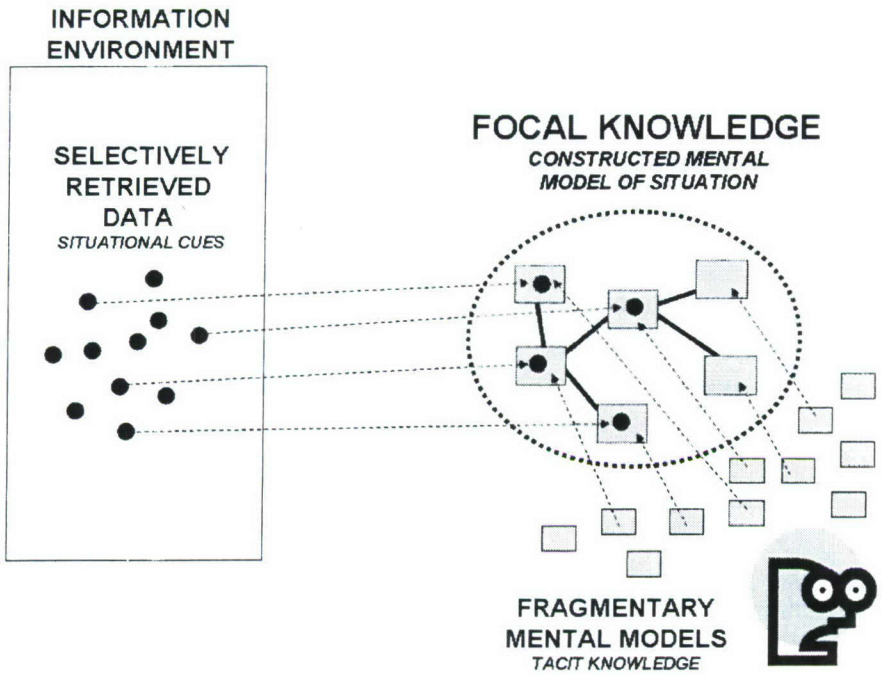

Figure 5. Visualization as the Construction of Focal Knowledge.

While the "state" of focal knowledge is actually a specific set of mental associations (neural activations) held at any given time by the individual, it can be usefully thought of as an abstraction-decomposition hierarchy of concepts that link elements of the perceived problem space in meaningful ways. Elements of this visualization space range from abstract concepts (e.g., what is the purpose or objective of the military operation) down to concrete objects within the operational environment (e.g., specifically targeted people, groups, facilities, etc.) An interpretation of one such hierarchy is shown in Figure 6, and is motivated by the earlier work of Rasmussen, Pejtersen, and Goodstein (1994) who systematically studied the structure of organizational work spaces (Rasmussen et al., 1994). As shown in this figure, construction of the commander's visualization space involves different levels of thinking as the commander forms his assessment of how he will move from the current state along a line of operation to some desired end state.

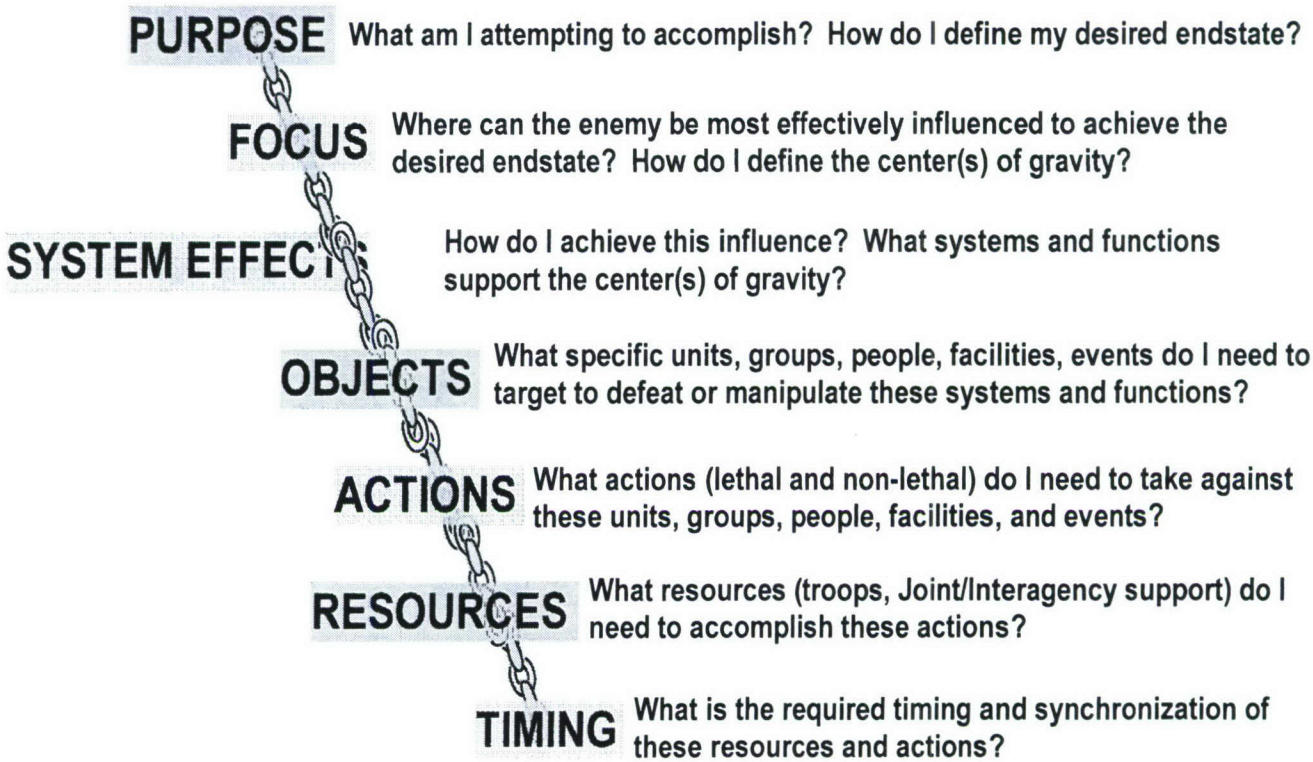

Figure 6. Levels of Visualization Thinking.

The visualization process begins with the question, "What am I attempting to accomplish?" This is then interpreted in terms of, "How do I define my desired endstate?" In other words, what set of conditions constitute mission success? Next, the commander thinks about his adversary and asks the question, "Where can the enemy be most effectively influenced to achieve the desired end state?" This is often expressed in terms of one or more centers of gravity that the commander has conceptualized. In modern stability operations, centers of gravity might be military combat power, a political organization, a civilian population, or some combination of several centers of power. Once centers of gravity are identified, the commander begins to ask, "How do I influence them in some effective way to move toward my desired end state? In addition, what operational environment effects like terrain and weather influence each center of gravity?" This requires the commander—supported by his staff—to look at the operational environment as a set of systems and functions that are potentially maintaining the enemy's centers of gravity. At this point, visualization moves from being purely conceptual in nature to being more analytical—that is, it involves understanding (1) how the various military, political, economic, social, information, and infrastructure systems operate together and (2) how these systems can be defeated or influenced in some desired way. For traditional combat operations, the commander could generally rely upon familiar battle calculus to form these assessments. In modern stability operations, he will likely have to rely upon others to provide expertise in the non-military areas.

Perhaps the most difficult aspect of visualization is reflected in the question, "What key units, groups, people, facilities, and events do I need to target in order to defeat or manipulate

these identified systems and functions?" This articulation of the commander's visualization is usually supported by intelligence collection and staff analysis. Yet, it is the part of visualization that begins to turn abstract thinking into concrete actions. At the next level of thinking, specific actions are paired with the identified key operational environment objects. These actions might include both lethal and non-lethal operations, depending upon the nature of the effect to be achieved. The next level of thinking identifies the resources required for these actions. This can involve troop-to-task analyses of the commander's own forces, as well as estimates of the support needed from other units and agencies. This might also involve negotiations with other stakeholders whose operations are affecting the commander's area of operation. Finally, the visualization is completed by thinking about the required timing and synchronization needed to coordinate these resources and actions into an effective operation.

While Figure 6 summarizes the major levels of thinking involved in visualization, these elements of thinking do not constitute an effective understanding of the operational environment unless they are logically tied together in an operational plan. Figure 7 illustrates how the commander begins to mentally link the different levels of thinking into an overall operational plan.

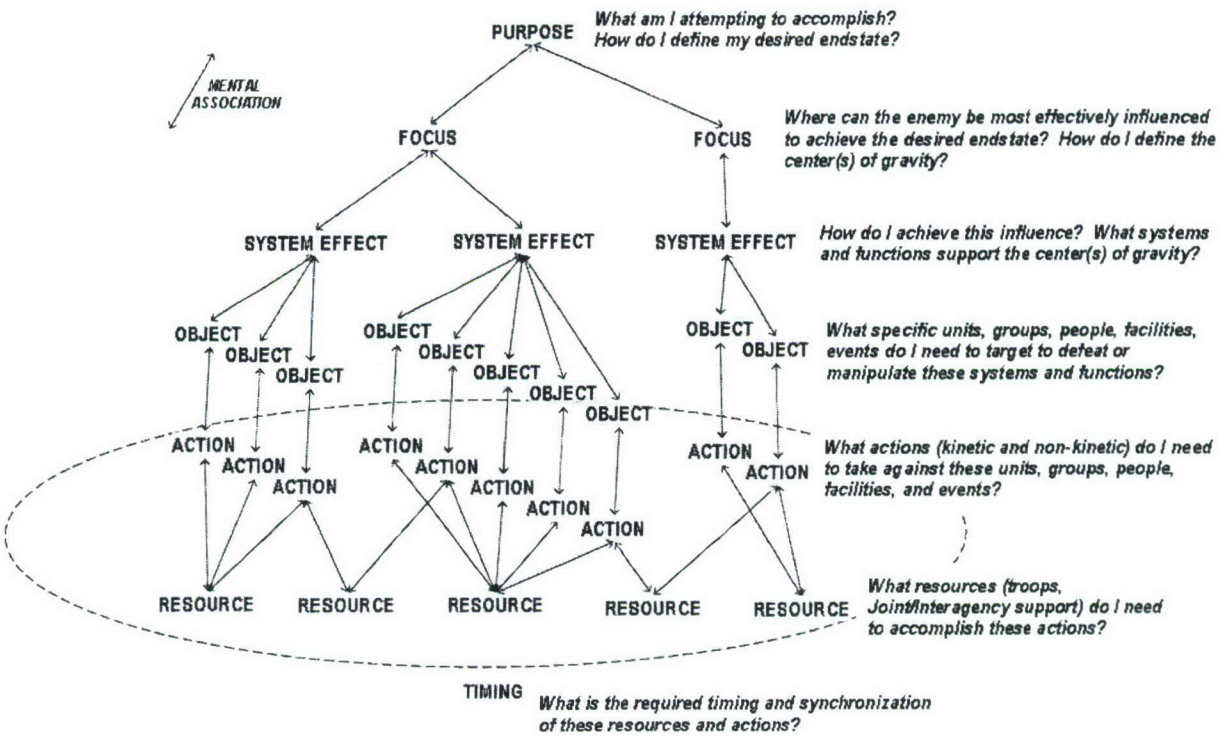

Figure 7. Commander's Visualization Space.

The visualization space shown in Figure 7 is somewhat generic—that is, it might describe the visualization framework of any type of organization. In order to apply this to a military organization, however, we consider the various doctrinal frameworks discussed earlier – specifically, METT-TC and the elements of operational design. The mapping of these frameworks to the generic visualization structure is illustrated in Figure 8. On the right side of Figure 8 are shown the traditional METT-TC elements. As seen here, these elements roughly map into the levels of thinking identified in Figure 7. For example, "mission" can be translated

into purpose. The "enemy" element of METT-TC is rather broadly defined and needs to be partitioned into focus, system effects, and operational environment objects. Similarly, "terrain" and "civilians" map into system effects, while "troops available" maps into resources. Finally, the "time" element of METT-TC is seen to correspond to the timing level of the visualization space.

While METT-TC elements constitute the basis for identifying the different levels of the visualization space, it is the elements of operational design that begin to tie them together in a purposeful manner. For example, "end state conditions" help to articulate purpose in terms of definable criteria for achieving success. Next, "centers of gravity" constitute abstract definitions of focus that reflect the commander's assessment of where and how the adversary can be defeated. Associated with each center of gravity is a line of operation (physical or logical) that provides a framework for defining purposeful actions. System effects are described in terms of "decisive points," "defeat mechanisms," and "culmination points." Battlefield objects (targets) and actions are defined in terms of the lethal and non-lethal options available to the commander. The pairing of actions with battlefield objects is further guided by the commander's specification of "operational reach," "simultaneity and depth," and "operational risk." Finally, "tempo" and "operational phasing" help to define the timing of actions and resources needed to achieve the intended system effects.

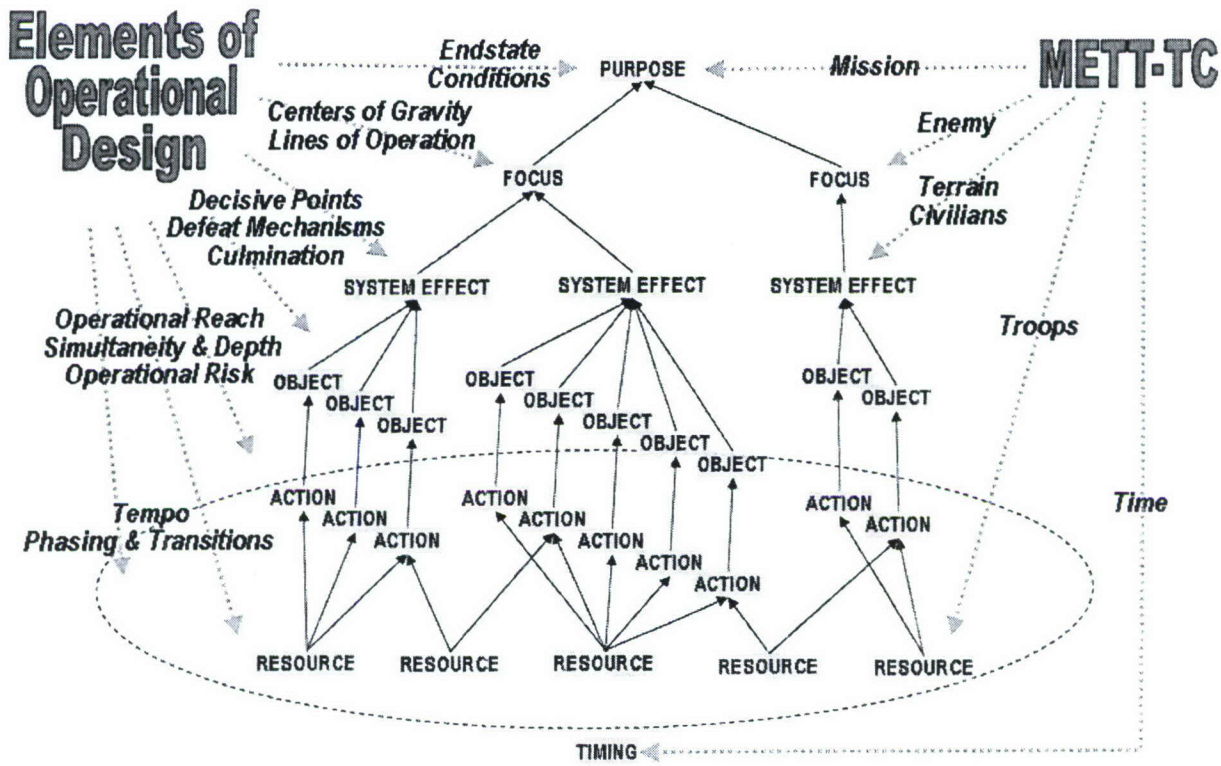

Figure 8. Mapping of METT-TC and Elements of Operational Design onto Visualization Space.

While METT-TC and the elements of operational design provide a guiding framework for organizing the commander's visualization space, they do not, in themselves, constitute the

mental process of visualization. To better understand this process, we must identify the underlying mental activities involved in constructing the visualization space—that is, the mental activities used to translate intent into a set of purposeful actions. How the commander constructs this framework has been investigated by Sieck, Klein, Peluso, Smith, and Harris-Thompson (2004). Essentially, this process involves the activation of specific mental model fragments—based upon the commander's experience and expertise and the recognition of relevant triggering cues from the operational environment. Once activated, mental model fragments provide a structure for interpreting other pieces of information from the commander's information environment. Available information is then used to validate the activated mental models, fill in missing features, or initiate a search for a more relevant model. Overall, this process is iterative in nature, with the goal being to find a set of mental model fragments and information elements that are consistent and mutually reinforcing of one another. In a more formal manner, the so-called "data/frame" model of Seick et al., involves a number of different mental processes that serve to maintain a consistent understanding of the current situation. In another area of research, Kurtz and Snowden (2003) have identified various types of metacognitive strategies for dealing with different level of situational disorder. An adaptation of their strategy framework to the concept of visualization yields a eighth mental activity considered relevant to the current research. Taken together, these eight activities form the cognitive core of visualization:

Seeking a Frame. This mental activity serves as the basic foundation of the visualization process. A frame is a mental model structure that is built from past experience and becomes part of an individual's store of tacit knowledge. A mental model is characterized by an overall theme or functional purpose (e.g., in this type of situation, take the following actions, with the following causal pathways and constraints, to achieve the following set of goals…) and is comprised of feature slots that can be instantiated by information describing a current situation. Feature slots can be associated with object classes, causal relationships, rules, principles, or any other type of mental construct that is deemed significant within the individual's past experience and training. Sometimes, many different fragmentary mental models can be causally linked within an individual's focal knowledge state to form a "just-in-time" explanation of a situation.

Visualization typically reflects a "pattern matching" mode of thinking in which an appropriate mental model is constructed—or activated—within the individual's focal knowledge state to provide a purposeful structure for interpreting available facts and other information. Activation of a specific mental model is typically triggered by matching salient facts to one or two key features that uniquely anchor the model—that is, specific data from the individual's information environment serves as critical cues that trigger the mental activation of a familiar model.

Frames are considered to be comprehensive in the sense that they typically include a complete set of feature slots corresponding to (1) key anchors or triggering cues, (2) goals and objectives, (3) salient objects and causal relationships, (4) a set of expectations, and (5) a set of response actions. The degree to which these features slots are instantiated with information from the current situation determines the level of understanding said to be achieved. Once activated, the feature slots associated with the frame serve to guide the search for new information.

Frames have sometimes been referred to as "schema," although there does not exist a precise definition of this construct in the psychological literature. In general, a schema reflects an expert's set of principles or strategies for solving a particular type of problem. Schema are developed and refined over time through experience—thus marking the individual as an expert in a particular area. Novices might understand what problem cues are relevant in a given situation, but they lack a refined schema that tells them what to do with this information.

Elaborating the Frame. This mental activity involves the gathering and fitting of available information to reinforce and expand a currently activated mental model of the situation. As the individual gathers facts about the situation, he mentally compares them with the feature slots that characterize the activated mental model and determines if they reflect a good fit. As more is learned about the situation, the mental model becomes more elaborate in terms of additional feature slots that match perceived elements of the situation. At the same time, the overall structure of the activated mental model provides a means for recalling the essential features that uniquely characterize the situation. Thus, the mental model becomes self-reinforcing inasmuch as its associated feature slots provide the individual with a set of expectancies and guide the search for additional information. For a complex situation, the individual might hold several fragmentary mental models that pertain to different aspects of the situation. Thus, focal knowledge might consist of a confederation of loosely coupled mental model structures, each providing a set of feature slots that "explain" a specific aspect of the problem space. As more and more fragmentary mental models are activated and joined in focal knowledge, the individual places higher confidence in the overall frame or mental model as a workable characterization of the current situation.

Questioning the Frame. This mental activity occurs when the individual discovers a situational anomaly—a fact that does not match the activated mental feature set. Detection of the anomaly violates the expectancies of the individual and potentially triggers two types of reactions, depending upon the perceived centrality or importance of the violated feature slot. The first reaction is a lowering of the overall confidence in the mental model as a correct explanation of the current situation. A second reaction is the initiation of alternative reasoning strategies—e.g., a shift away from the automatic adoption of familiar mental models to a more deliberate search for meaning patterns. This aspect of reasoning will be addressed later as part of the discussion on metacognitive strategies.

Preserving the Frame. This mental activity—in contrast to the previous activity of questioning the frame—serves to maintain the activated mental model in the face of contradictory facts or evidence. Instead of questioning the validity of the model, the individual reasons that the anomalous information is either unimportant or can be "explained away" by other perceived aspects of the situation. There are no hard and fast rules that govern when a mental model should be preserved or questioned. Maintenance of a specific mental model serves to provide situational focus, cognitive efficiency, and purpose of action. On the other hand, adhering to a set of beliefs in the face of overwhelming contradictory evidence is likely to lead the individual to make disastrous or counterproductive decisions. Stated differently, rigid adherence to an activated mental model leads to cognitive distortions, flawed interpretations, and fixation errors of judgment. Knowing when to maintain and when to abandon a specific understanding framework is a matter of experience and seasoned judgment.

Comparing the Frame. This mental activity addresses information equivocality—that is, information that supports two or more possible explanations or interpretation of the situation. Unlike the discovery of anomalous information which leads to the questioning of an activated mental model, this case reflects a situation where a specific piece of information matches the salient cue triggers for two or more mental models. In such cases, the individual acts to gather additional information that serves to sharpen the distinction between different mental models by filling in additional feature slots. The comparison of alternative explanation requires additional mental energy and is generally undertaken in a more deliberate—rather than automatic—manner. The goal of this function is to eventually select which of the competing mental models best fits the available information as a whole. In some cases, however, the individual can use the simultaneous activation of competing mental models as a framework for planning risk mitigation actions.

Reframing. As a situation evolves over time, the individual needs to adjust their understanding to emerging features of the situation. Reframing is the mental activity that accomplishes this adjustment. Reframing can include several different mental activities, with their use dependent upon the specific needs of the moment. One aspect of reframing involves the identification of new anchors—i.e., features of the situation that suddenly take on significance through pattern analysis, the occurrence of unanticipated events, or collaboration with someone who brings a new perspective to the visualization process. New anchors potentially reflect any type of feature slot, including goals and objectives, key objects and causal relationships, and available actions.

A second aspect of reframing involves the recovery of understanding when a significant number of expectations do not match reality. At this point, the individual experiences the feeling of being "lost," lacks confidence in their understanding of the situation, and realizes the need to reconstruct their focal knowledge. As discussed next, this situation invokes the metacognitive process of deciding if and when to switch to a different sense-making strategy.

Managing the Framing Cycle. The data/frame model of sense-making developed by Seick et al., primarily deals with familiar situations in which the individual possesses relevant experience and expertise to deal with the problem space. However, this is not always the case in many real world situations where a known problem calculus cannot be applied. To address this broader visualization challenge, the individual must first characterize the level and nature of disorder being faced. Then, depending upon the type of situation at hand, the individual adjusts the framing cycle to one of the models depicted in Figure 9. These models reflect an adaptation of the work of Kurtz and Snowden cited earlier.

The most ordered domain for visualization is the Known quadrant where cause/effect linkages are fully known from past experience, empirically testable, and predictable in the future. This part of the world operates according to linear relationships and a known or well-understood operational calculus. Here, the individual can employ experienced-based mental models to frame and interpret available data from the information environment. The framing cycle can be seen as one of organizing the available information according to an activated mental model, followed by the execution of response actions associated with that model. In this type of

visualization environment, the individual strives to achieve maximum efficiency of thinking and action.

The Knowable quadrant reflects a situation in which a part of the world still operates linearly, but not everything is immediately understood. Hence, the individual must employ analysis, fact-finding, and collaboration with others to reveal what can be potentially known about the situation. These actions, however, expend time and effort and detract from the individual's ability to respond efficiently to the operational situation. The framing cycle follows the pattern of information search (guided by the activated mental model), information collection, information classification into relevant feature slots, and execution of response actions associated with the activated model.

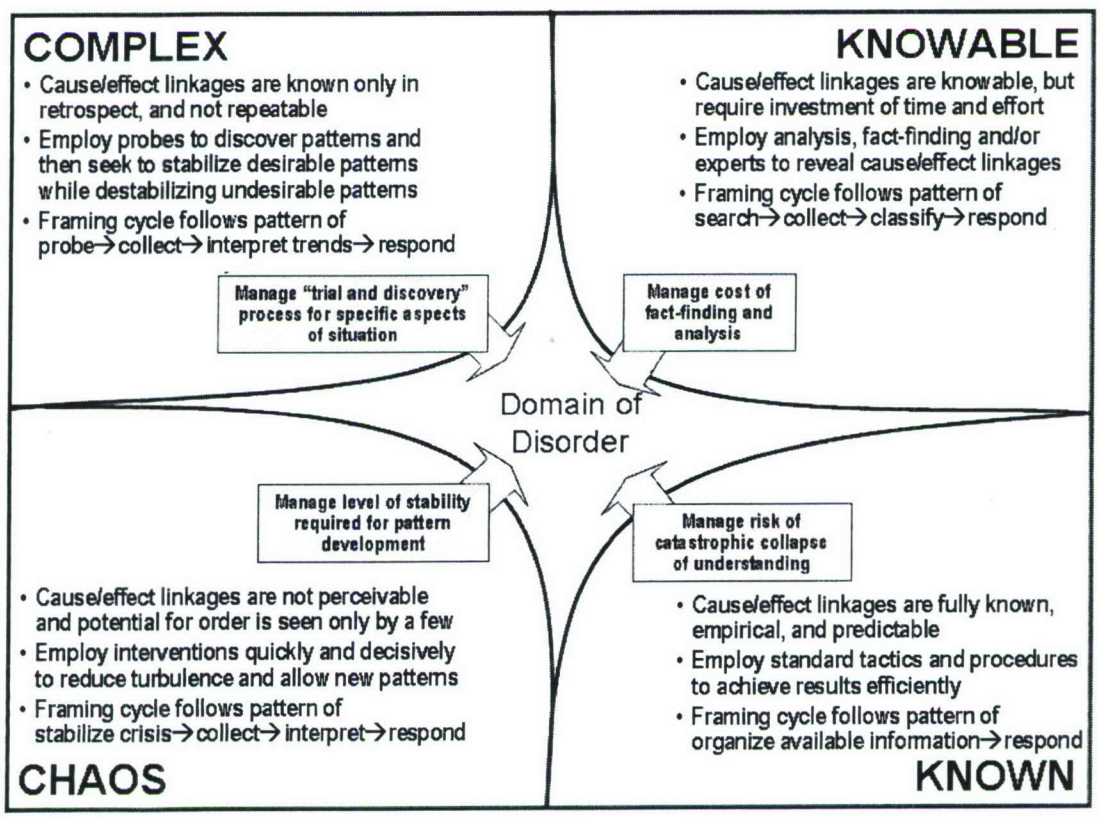

Figure 9. Visualization Strategies for Dealing with Different Levels of Disorder.

The Complex quadrant reflects a complex, emergent situation in which causal relationships are generally discovered and known only in retrospect. These relationships cannot be easily fit to a currently activated mental model (as in the Known or Knowable quadrants). Attempts to respond according to past experience will generally be unproductive and unable to cope with the new and novel situation. Here, the individual uses probing actions or acts in a "trial and discovery" mode to reveal and detect causal patterns as they currently exist. These patterns, in turn, might suggest specific anchor cues that will trigger the activation of one or more fragmentary mental models. The individual can then employ actions to stabilize those patterns or trends found desirable, while taking other actions to destabilize those patterns or

trends deemed unproductive. Here, it is important for the individual to consider the operational situation from multiple viewpoints so as to fully understand the significance of relevant patterns and trends. It is also important for the individual to realize that a complete mental framework for understanding the overall situation is unlikely to emerge. Rather, the framing process continues as an ongoing cycle of employing pattern analysis to develop partial understanding of specific aspects of the situation.

The Chaos quadrant reflects a totally destabilized situation in which it is generally difficult or impossible to identify meaningful patterns and trends. Here, the individual acts to quickly and decisively intervene in order to reduce turbulence and bring stability to the situation. As compared with the Complex quadrant, action-taking is more deliberate in order to stabilize the situation to the point where meaningful patterns can be discerned and new fragmentary mental models can be activated to provide situation understanding.

The area in the center of Figure 9 reflects that fact that each of these framing strategies serves to reduce the amount of disorder in the operational situation. Here, the term "disorder" implies the lack of an adequate focal knowledge framework within which the individual can take meaningful action. As suggested by the four quadrants, "disorder" can arise from the lack of several different things: familiar mental models, information required by familiar mental models, discernible patterns/trends, and situational stability. In each case, the individual's visualization process attempts to push the boundaries of each quadrant to the center, thereby reducing the amount of "disorder" while increasing the opportunity for purposeful action. The four gray boxes shown at these boundaries reflect different metacognitive strategies for managing the framing process. They include:

- Managing the risk of catastrophic collapse of understanding (knowing when a set of activated mental models no longer provides an appropriate interpretation of the situation and a guide for response action taking),
- Managing the cost of fact-finding and analysis (knowing how much time and effort can be afforded to validating a currently held mental model vis-à-vis the need to invoke response actions),
- Managing the "trial and discovery" process of understanding different aspects of the situation over time (knowing what types of probing actions and pattern analysis are required to identify new fragmentary mental models), and
- Managing the level of operational stability (knowing when and where to employ decisive actions to stabilize specific aspects of the situation—thus allowing the opportunity for meaningful patterns to emerge).

To summarize the cognitive level of analysis from a training point of view, visualization can be seen as the mental process of linking intent with action within a constructed problem space. The problem space consists of a hierarchically arranged set of mental constructs that define the purpose, focus, relevant system effects, objects, actions, resources, and timing of the commander's operation. These constructs are identified through different levels of thinking that form the commander's assessment of how he will move from the current state of the operational environment through various lines of operation to a desired end state. The identification and linkage of these constructs are based primarily upon the tacit experience and expertise of the

commander and his staff. Relevant cues from the unit's information environment serve to trigger or activate specific mental model fragments which are then instantiated by other available information and linked together to form complete associational pathways between intent and action. The overall process of constructing the visualization framework is dynamic in nature as the operational environment evolves, new information cues become available, and different mental models are refined and integrated into the overall hierarchical structure.

While Army doctrine can guide this mental process through mnemonics such as METT-TC and the elements of operational design, it cannot prescribe "cookbook" solutions for constructing and linking the set of mental constructs. Such devices merely serve to direct the commander's attention to different aspects of the problem space. Rather, it is the creative application of the commander's tacit experience and expertise at each level of thinking—purpose, focus, system effects, objects, actions, resources, and timing—that reflects the "art of war." In known or familiar situations, the commander can rely upon traditional battle calculus to identify the various elements of the visualization space. However, in more complex or chaotic operational environments (e.g., stability operations), the identification and linkage of relevant system effects, objects, actions, and so forth will be more creative in nature and rely on expertise outside of his personal area of experience.

Regardless of how this is accomplished, the mental goal of visualization is to develop a set of conceptual pathways that link intent with action. To the degree that this visualization space is externalized in the form of an explicit mission analysis, the commander is able to continually adjust his execution decisions with reference to this structure as the operational situation evolves. In this manner, the visualization serves as a roadmap or guide for maintaining unity of purpose and synchronization across the various elements of his operation. If this visualization space is not explicitly expressed and maintained, the commander runs the risk of myopically narrowing his attention on moment-to-moment actions while losing sight of the "bigger picture" involved in achieving mission success.

Social Level of Analysis

While visualization is primarily addressed as a cognitive process occurring within the individual, there are important aspects of visualization that must be considered at a social level of analysis. Addressing this process at the social level is necessary because the knowledge required to link intent with action is typically distributed across an organization, rather than being concentrated in one mind (Tsoukas, 1996; Swart & Pye, 2002). Accordingly, visualization, as it occurs within an organization such as a Battalion Task Force, is very much a social process that produces integrated—or even what might be considered at times a negotiated—understanding and unity of purpose. While the commander is responsible for building the overall visualization of his operation, he will typically be assisted by one or more key staff officers—e.g., his executive officer (XO), intelligence officer (S-2), operations officer (S-3), and/or civil military affairs officer (CA). At the same time, the commander's visualization process might be influenced or shaped by stakeholders and experts outside of his unit—e.g., local special operations team leader, air liaison officer, USAID representative, local civilian administrative or political figure. Within such a process, all of these individuals can play specific knowledge creation and management roles, represent specific organizational interests and perspectives, and

provide unique areas of tacit knowledge expertise. The integration of these individuals into a cohesive visualization process involves the need for effective collaboration and the systematic organization of different knowledge creation tasks into a cohesive work flow or battle staff rhythm. Figure 10 illustrates the basic nature of the visualization process from a social analysis perspective.

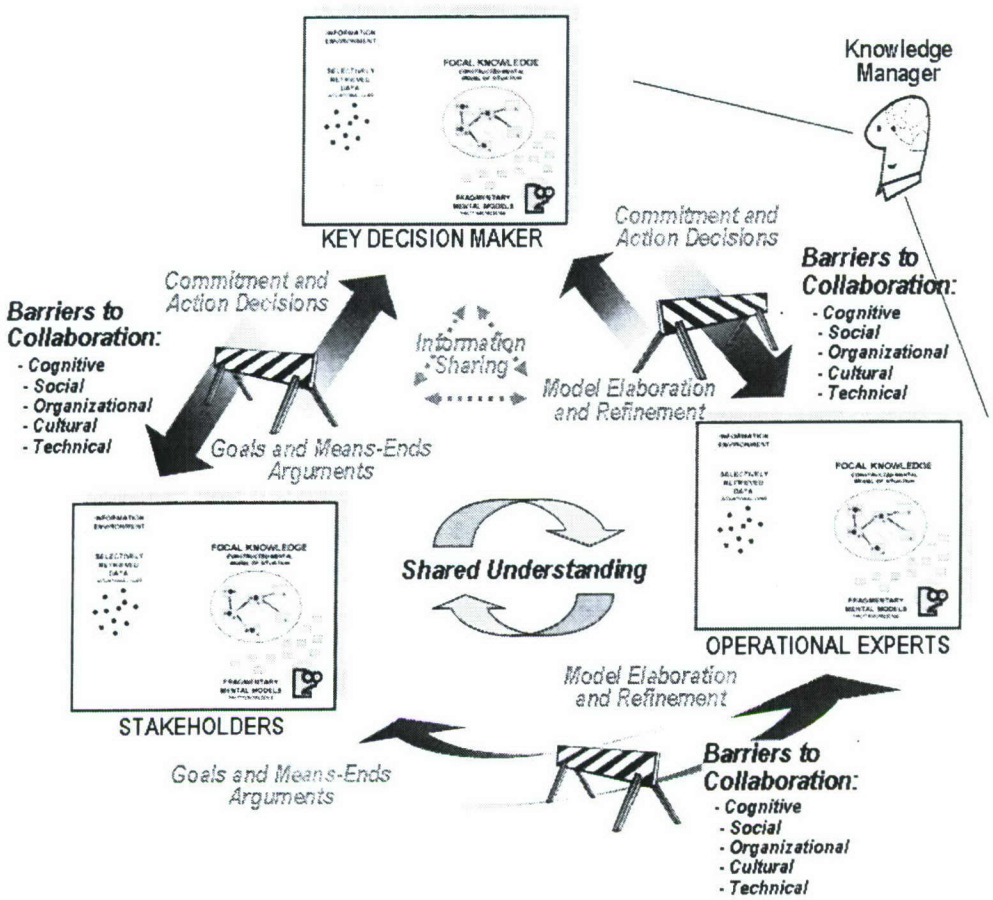

Figure 10. Visualization from a Social Analysis Perspective.

Key elements of this model to consider from a training perspective include the knowledge creation and management roles played by specific individuals. For example, the commander plays the role of the key decision-maker responsible for framing the overall shape and focus of the problem space. This same individual—with his positional authority—also commits the remainder of the organization to focus their mental resources and energy according to this framed problem space. As noted earlier, this problem space will likely be structured in terms of METT-TC dimensions and the elements of operational design. A second type of visualization role is played by the operational experts (e.g., XO, S-2, S-3,) that support the commander. These individuals work within framework established by the commander to develop the various levels of actionable knowledge depicted earlier in Figures 6, 7, and 8. That is, they elaborate and decompose high level intent and vision into the specific operational environment functions and nodes that must be acted upon to achieve the operational objectives. A third type of visualization role shown in Figure 10 reflects other stakeholders with whom

which the commander must coordinate. Here, the visualization role is one of reconciling potentially conflicting goals and means-ends strategies into a cohesive and synchronized operation. For example, in stability operations, these stakeholders can include representatives of the other joint, interagency, and coalition agencies and organizations that are operating within the commander's AO, but do not fall within the same chain of command. From a social perspective, these representatives act to negotiate shared understanding and unity of purpose. Finally, there is the role of knowledge manager—someone charged with the responsibility of overseeing the effective synchronization of these various visualization roles within and across the organization. This role might be assumed by the commander, or might be delegated to a specific staff member—e.g., XO, or Battle Captain. The role might be carried out in an explicit manner—e.g., designated within the unit's standard operating procedures—or remain something that is only implicitly addressed in the course of organization's visualization process.

In terms of Army doctrine, the tactical commander (e.g., battalion commander) is supported in his visualization process by the XO who, as second in command, is considered a combat leader prepared to assume command at any time. Accordingly, the XO must be mentally involved in the visualization process and understand the commander's rationale for building the overall visualization structure. In addition to the XO, operational experts comprising the commander's personal staff, coordinating staff, and special staff add their unique areas of expertise to constructing the lower level elements within the visualization space. The coordinating staff typically reports through the XO and has responsibility for building the visualization details across the commander's entire field of responsibilities—except in areas that the commander decides to retain personally or in areas specifically reserved by law or regulation for specific staff officers (Department of the Army, 2000a). The coordinating staff includes the following operational or functional experts:

- S-1 (Adjutant) - responsible for addressing personnel, medical, legal, civil affairs, public affairs, religious, morale, detainee, and casualty evacuation aspects of the visualization space;
- S-2 (Intelligence Officer) - responsible for the intelligence preparation of the battlefield (IPB) process, weather analysis, reconnaissance/surveillance planning, and targeting process that develops the system effects and operational environment objects elements of the visualization space;
- S-3 (Operations and Training Officer) - responsible for developing and coordinating details of the commander's operational maneuver and engagement plan that specifies the actions, resources, and timing elements of the visualization space—including (with the aid of other staff sections) logistics support, psychological operations, electronic warfare, jamming/electronic countermeasures (ECM), operations security, counter-reconnaissance, deception, engineer, chemical, air defense, communications, and signal support; and
- S-4 (Logistics Officer) - responsible for developing and coordinating the resources and timing elements of the commander's visualization space—including the designation of lines of movement and logistics locations, the timing of combat service support operations, and the pushing of supplies forward.

Likewise, the commander's special staff addresses specific technical or functional areas of the visualization space. These operational experts can report either through the XO or directly to the commander, depending upon the commander's preference, and serve to develop the lower level details of specific areas of the commander's visualization space. This staff typically includes the following individuals:

- Headquarters Company Commander responsible for logistical support of the command facilities;
- Fire Support Officer responsible for developing and coordinating fire support actions and resources into the maneuver operation—including (typically) both lethal and non-lethal actions that comprise an essential part of stability operations;
- Nuclear, Biological, and Chemical Officer responsible for addressing these specific types of threats within the commander's visualization space;
- Battalion Signal Officer responsible for advising, managing, and directing all aspects of the unit's communication systems;
- Scout Platoon Leader responsible for assisting the commander in conducting tactical reconnaissance operations that enable the commander to instantiate and refine his visualization of the operational environment;
- Battalion Mortar Platoon Leader responsible for advising the commander and Fire Support Officer on the employment of the battalion mortar unit;
- Weapons Company Commander (in an Infantry Brigade Combat Team [IBCT]) responsible for advising the commander on the tactical employment of the battalion's Antiarmor and gun high mobility multi-purpose vehicle (HUMMWV) resources—including their use as an additional maneuver unit;
- Engineer Company Commander (in an Heavy Brigade Combat Team [HBCT]) responsible for advising the commander on terrain/obstacle issues and the tactical employment of the battalion's engineering resources; a
- Surgeon responsible for advising the commander on the medical aspects of the visualization space, including the treatment and evacuation of wounded and sick personnel.
- The personal staff work under the immediate control of the commander and have direct access to him. Most personal staff officers also perform duties as special staff officers working with a coordinating staff officer. They do this case-by-case depending on the guidance of the commander or the nature of the task. This staff typically includes the following individuals:

    - Battalion Sergeant Major responsible for advising the commander on enlisted matters.
    - Chaplain responsible for advising the commander on the religious welfare, morals, and morale of the unit, as well as assisting the S-2 Officer in visualizing local religious organizations and activities.

In current stability operations, increased emphasis has been given to visualizing, coordinating, and executing civil military affairs actions. As part of this emphasis, Army civil affairs units primarily serve to support civil military operations as part of the commander's overall campaign. In addition, these units are organized to support allied forces, the services,

U.S. government agencies, agencies of other countries, and various information operations. Civil affairs units exist at various echelons of command, with the chain of command prescribed by the geographic combatant commander (Department of the Army, 2000b). At the tactical level, civil affairs companies are organized to deploy with and support both maneuver commanders and special operations forces commanders as needed with language-trained, theater-oriented planning experts, linguists, and regional and cultural expertise. Civil affairs companies, in turn, include civil affairs teams that can deploy as part of a maneuver unit to augment the maneuver unit's staff with civil military operations planning and assessment expertise. This expertise cuts across many different knowledge areas that might be outside of the maneuver unit's organic areas of experience, including (at the civil affairs brigade level) public administration, public safety, veterinary medicine, international law, health services, civilian supply, sanitation, public works and infrastructure, linguistics, agriculture, economic development, environmental management, cultural relations, civil information, dislocated civilians, and contracting. At the civil affairs battalion level, functional expertise is provided on foreign internal defense, unconventional warfare, humanitarian affairs, coalition support, information operations, security assistance, countermine activities, counter-drug operations, and combat search and rescue that can assist maneuver units in developing civil affairs-related estimates, plans, and annexes. At the company level, a civil affairs company can provide specific resources to augment those of a maneuver unit—e.g., dentist, physician assistant, construction engineer, veterinary officer, and so forth. In terms of visualization, the complexity of stability operations will typically exceed the range of expertise organic to the maneuver unit. Accordingly, the augmentation of the commander's staff with a civil affairs team will play a major role in developing the political, economic, social, information, and infrastructure elements of the commander's visualization space.

Both civil military affairs and special operations emphasize the broader principles of warfare that must be considered by commanders at every echelon of command. Here, Army doctrine outlines a number of imperatives that must be factored into the commander's visualization space, among which are:

- Identify and understand the relationships and interactions between variables in the civil environment, including the impact of specific military actions on the civil environment and the subsequent reactions and potential opportunities to assist the military mission;
- Recognize the political implications of military involvement, including the multitude of interrelated issues, positions, and interests associated with the agendas of various groups and individuals within the civilian environment;
- Facilitate interagency activities, including the coordination of security, economic development, governance, and humanitarian assistance activities;
- Engage the threat discriminately, including consideration of the political, economic, and social consequences that create the possibility of needless social instability subsequent to military operations;
- Consider long-term effects, including the assessment of how military operations can lay the foundation for—rather than hinder—subsequent political, economic, and social objectives; and

- Anticipate and control psychological effects—specifically the effects linked to the perceptions of the civilian populace and key civilian leaders (Department of the Army, 2000b).

These imperatives imply the need for the commander to factor the perspectives of other stakeholders into his visualization space. Specifically, the commander must be prepared to identify and link the objectives and actions of key civilian leaders, agency representatives, and other unit leaders operating within his AO. In short, this involves a "reverse visualization" process wherein the commander is able to view his operation from the perspective of another decision-maker who can potentially influence his operational environment.

As depicted within Figure 10, these various visualization roles exchange information in the form of commitment and action decisions, mental model elaboration and refinement, and goals and means-ends arguments. However, the effective exchange of this information is potentially influenced by a number of different barriers to collaboration. Examples of these barriers that should be addressed in the training of visualization management skills include:

- Cognitive Capacity - The ability of each individual to comprehend and interpret information from another operational domain, depending upon their level and areas of experience.
- Interpersonal Trust - The willingness of others to share information with an individual, depending upon their level of interpersonal familiarity or their length of assignment to the organization.
- Parochial Barriers - The existence of inter- or intra-organizational boundaries that inhibit the flow of information, including procedural differences and access restrictions.
- Social Currency - The willingness of others to seek the advice or technical contribution of an individual, depending upon their recognized expertise or usefulness.
- Connectivity - The physical or electronic connectedness of an individual with the organization, depending upon physical location or electronic bandwidth and reliability.
- Expressive Power - The degree to which collaborative work tools allow physically separated individuals to articulate and share concepts and strategies.

In order to overcome some of these barriers, an organization typically organizes its collaborative visualization process in terms of a systematic sequence of planning and decision-making activities. For most military organizations, such a sequence of activities defines its battle rhythm or staff rhythm. This type of social organization accomplishes several goals, including the efficient use of personnel, the orderly regulation of expectations and information flow, the orderly production of knowledge products, and the focusing of attention on different time horizons of activity and concern. The general nature of this social structuring is depicted in Figure 11. As shown at the top of this figure, a military organization typically organizes its knowledge creation and decision-making process on a cyclical basis. The periodicity of this cycle might be geared to major operational phases or the availability of key individuals. The purpose of the cycle is to establish a timeline that specifies when individuals must be available for collaboration, when specific knowledge products must be delivered and shared within the organization, and when key decisions are made that commit the organization's mental resources and energy to specific directions and tasks. While the top of this figure depicts a linear or

cyclical process of sharing knowledge products and making commitment decisions, the bottom part of this figure reflects an ongoing—or asynchronous—process of knowledge creation. That is, different communities of interest form along functional lines to address different aspects of the planning and execution process. These communities of interest generally operate on an asynchronous basis, based on the availability of their respective participants. However, the knowledge products of each of these collaborative work groups flow into the cyclical staff rhythm at regular, defined points. The level of social complexity will vary with level of command. At an operational level of command, a headquarters can involve scores of individuals organized across a set of formally defined boards, working groups, and cells. At a tactical level of command, the process generally includes the commander interacting with his personal staff, coordinating staff, and special staff.

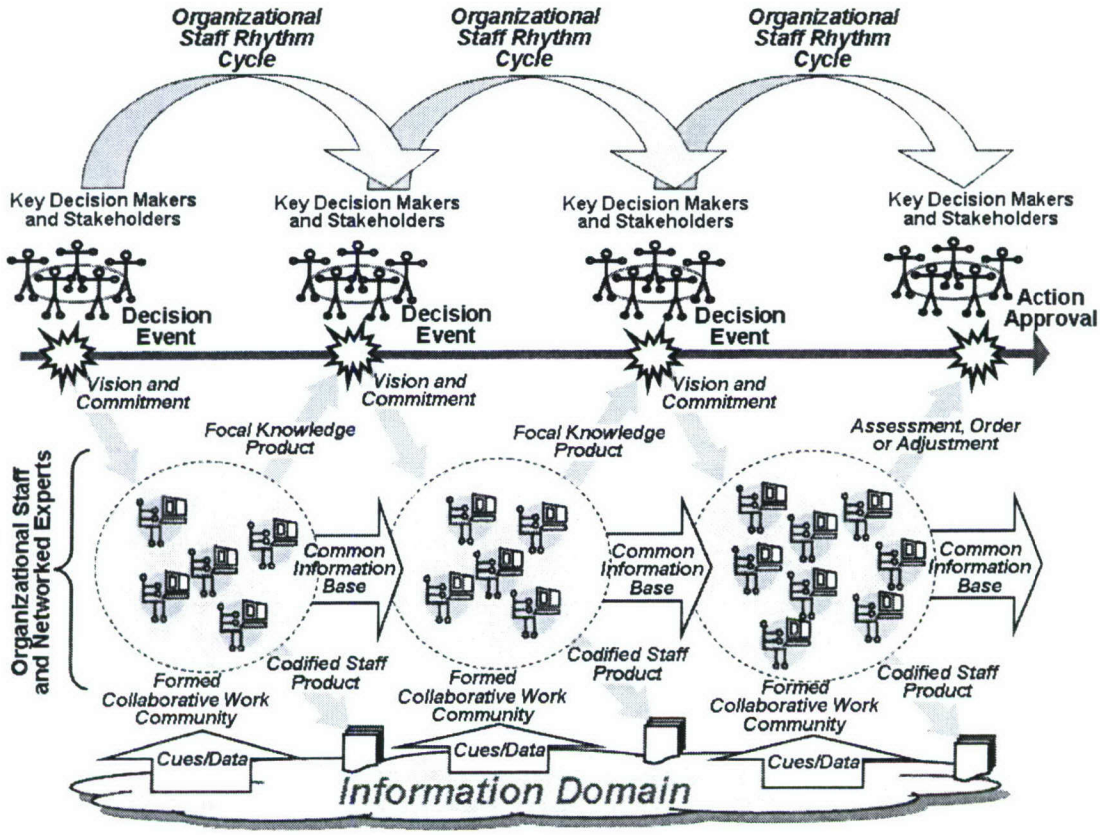

Figure 11. The Social Organization of Knowledge Creation and Decision-making.

In terms of current U.S. Army doctrine, the cyclical process of knowledge creation and decision-making follows the MDMP model shown in Figure 12 (Department of the Army, 2005). Here, the MDMP reflects a sequence of collaborative mental work tasks that translate a received set of mission orders into a set of operational plans and orders. Shown also are the specific knowledge products that codify the commander's focal knowledge space at each step in the staff rhythm. As noted earlier, the level of social complexity—and, hence formality—of the MDMP can vary according to level of command. At an operational or joint level of command, the MDMP will usually be very formalized in nature, whereas it might be somewhat informal at a

tactical level of command. Figure 13 depicts the same MDMP model in terms of the U.S. Army's doctrinal concept of "visualize-describe-direct" discussed earlier in this paper (Department of the Army, 2005).

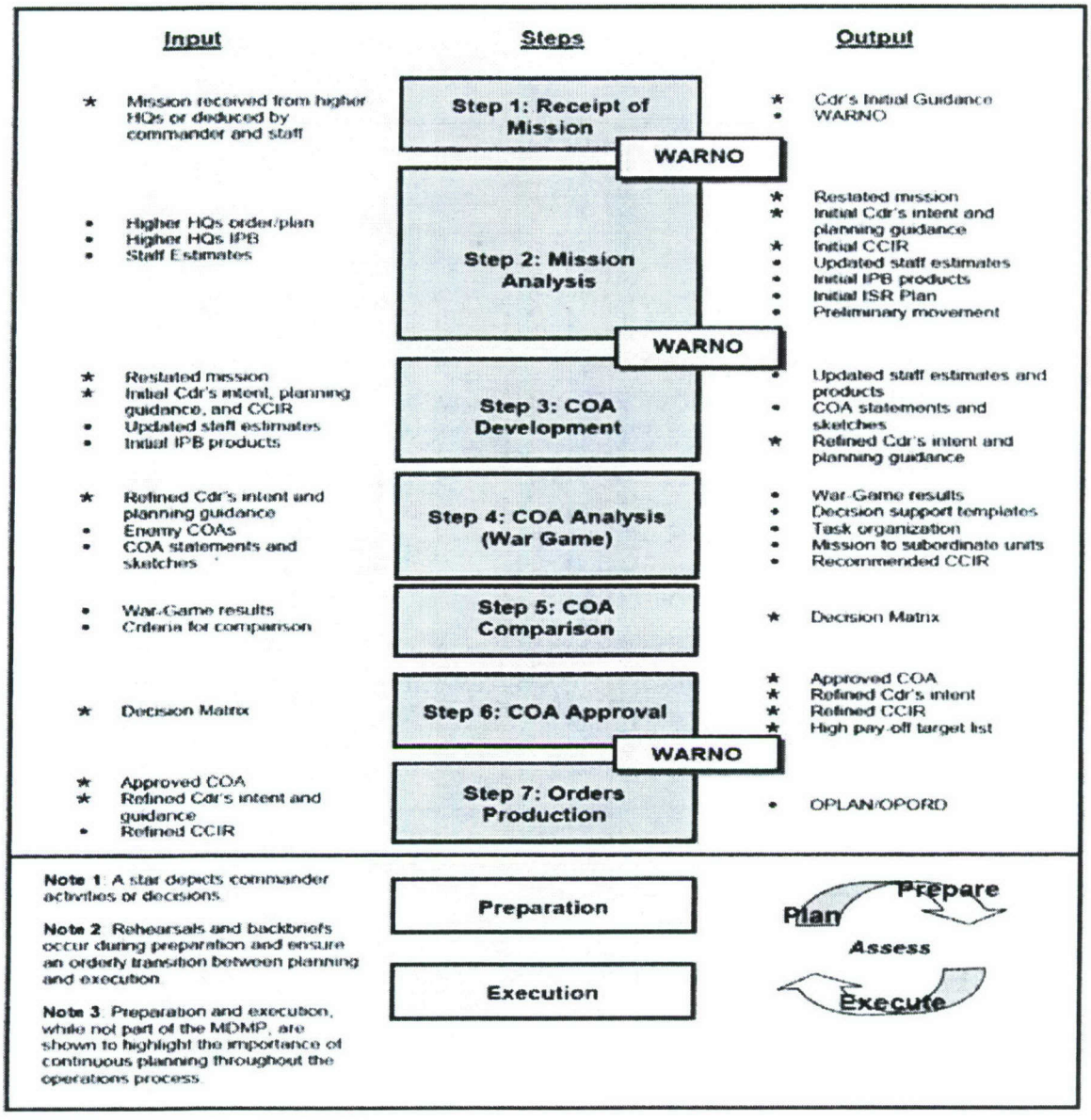

Figure 12. Military Decision-making Process (MDMP) Model.

It is significant to note in Figure 13 that the commander's visualization process is seen occurring continuously throughout the entire MDMP cycle. Complementing the commander's visualization process is the continuous staff process of maintaining a running estimate of the situation. Together, these commander and staff processes collaboratively form the critical step of mission analysis within the overall MDMP. From a psychological point of view, the commander's visualization and staff's running estimate are but different components of the focal knowledge structure illustrated earlier in Figures 6, 7, and 8. That is, the commander's visualization focuses primarily on defining the higher level knowledge elements—e.g.,

objectives, end states, centers of gravity—whereas the staff's running estimate focuses on expanding the articulation and analysis of the lower knowledge elements—e.g., supporting mechanisms and pathways, operational environment objects, and actions and effects. Thus, they are both important components of visualization.

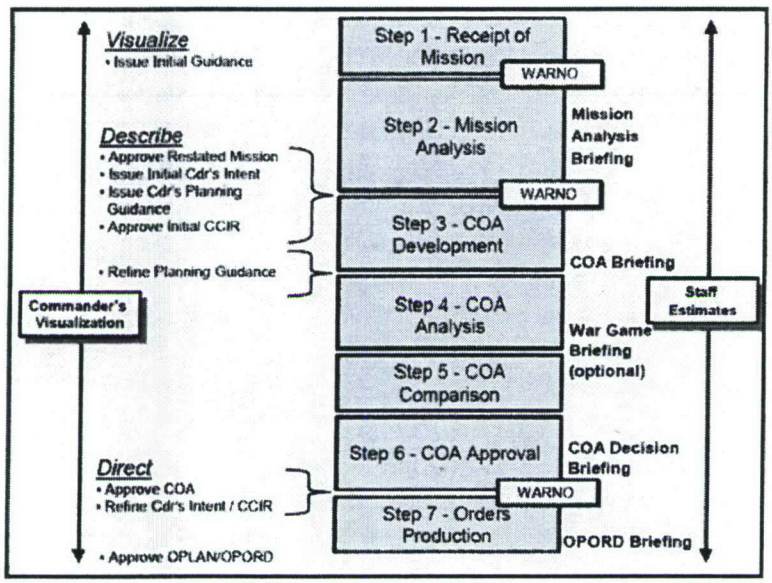

Figure 13. MDMP Depicted in Terms of Commander's Visualization and Staff Estimates.

The continuous nature of maintaining the commander's visualization and the staff's Running Estimate underscores an important point that has been sometimes misinterpreted in the past. The MDMP model depicted in Figure 12 can lead one to infer that Mission Analysis is merely a step undertaken in its entirety at the beginning of the decision-making process—that is, once completed, the commander and staff are assumed to move on to other steps in the MDMP. While this might have been the emphasis given in traditional linear combat operations, such is not the case in an evolving stability operations situation. For stability operations, the MDMP model depicted in Figure 13 is more accurate inasmuch as the requirement exists to continuously update and maintain both the commander's visualization of the operational environment and the staff's more detailed running estimate of the situation. While this distinction is a matter of degree, it is nevertheless an important one to consider in the training of effective visualization thinking skills.

As suggested by both Figures 12 and 13, important parts of the visualization process focus on (1) the development and continuous update of the Mission Analysis and (2) the development and refinement of the Course of Action. These documents serve to codify the commander's focal knowledge space in an explicit manner that allows this knowledge to be shared across the command system. From a social perspective, these knowledge products epitomize shared understanding and unity of purpose.

Mission Analysis. The first of these products, the Mission Analysis, explicitly codifies several aspects of implicit knowledge currently activated within the commander's visualization space:

- Commander's Intent – A clear, concise statement of what the force must do and the conditions the force must meet to succeed with respect to the METT-TC. The commander's intent statement encapsulates his focal knowledge and focuses the effort throughout the operational process. This articulation of focal knowledge includes (1) the desired end state, (2) key tasks (and effects) deemed essential for achieving that end state, and (3) the expanded purpose of the mission that provides the strategic and/or operational context for understanding the significance of the desired end state.
- Planning Guidance – An elaboration of the commander's focal knowledge that adds depth and clarity to his visualization, reflects his application of experience and judgment regarding the identification of one or more centers of gravity, articulates their supporting mechanisms and pathways in terms of envisioned decisive points, and describes his vision of how combat power and other resources might be prioritized and concentrated against each of these decisive points.
- Commander's Critical Information Requirements – Elements of additionally needed information that directly serve to validate or refine critical aspects of the commander's visualization or focal knowledge space. The Commander's Critical Information Requirements (CCIR) are uniquely determined from the fragmentary mental models currently activated as part of the commander's focal knowledge. That is, they are unique to the commander's personal understanding and situation-dependent in terms of supporting his assessment of current operations and prediction of future operations. Consequently, they are considered to be dynamic in nature as the commander's understanding and vision are refined over time. Because this visualization process is tied to action-taking, CCIRs are also time-sensitive or time-perishable in nature. Doctrinally, CCIRs include both Priority Intelligence Requirements (PIR) and Friendly Forces Information Requirements (FFIR). The PIRs reflect those elements of information considered by the commander to be most critical to decision-making and the success of the operation. They primarily address the enemy, terrain/weather, and civilian aspects of METT-TC. The FFIRs complement PIRs and deal primarily with the mission, troops, and time available aspects of METT-TC. Although not doctrinally a part of CCIRs, Essential Elements of Friendly Information (EEFI) reflect critical aspects of a friendly operation that, if revealed, would subsequently compromise the success of the operation.

While the Commander's Intent, Planning Guidance, and CCIRs reflect top-down contributions to the focal knowledge space, a corresponding set of staff-generated products begin to elaborate the focal knowledge space in a bottom-up manner. That is, while the commander is shaping the focal knowledge space in terms of high-level intent, broad guidance, and key information needs, the staff is beginning to expand this knowledge hierarchy in terms of detailed mental models of the causal mechanisms and pathways, objects, actions, and effects by which the operational environment will be influenced and moved toward a desired end state. These corresponding knowledge products include the following:

- Intelligence Preparation of the Battlefield – the systematic and continuous analysis of the threat and environment, including terrain, weather, and civil considerations. Intelligence Preparation of the Battlefield (IPB) supports the commander's visualization process by developing the fragmentary mental models needed to define key elements of the operational environment, describing the effect of these environmental elements on the

operation, producing an evaluation of the threat, and developing possible enemy courses of action. Although the Intelligence (G-2)/S-2 staff section leads the IPB process, this detailed visualization activity involves expertise from across the entire staff—particularly after the force employed. As noted in recent U.S. Army doctrine:

> IPB remains the same for all types of military operations; however, its focus may change depending on the predominant type of operation or the unit's primary focus. Products required to portray the information may also change based on the type of operation. Doctrinal and situation templates used to portray conventional threats differ from those used to portray asymmetric threats. In addition, civil considerations have assumed an importance on a par with the enemy and environment for all types of operations (Department of the Army, 2006a, p. 3-9).

- Intelligence, Surveillance, and Reconnaissance Planning – the continuous identification, synchronization, and tasking of information collection resources in response to the established CCIRs. Careful planning of how the available intelligence, surveillance, and reconnaissance (ISR) assets will be employed reflects a proactive component of managing the knowledge creation process within a military force. The management of ISR assets is particularly important with respect to visualizing the "Knowable" and "Complex" aspects of the operational environment defined earlier in Figure 6. This continuous process is dynamically driven by the evolving state of the CCIRs in order to make efficient use of these limited assets while avoiding overloading the commander and staff with irrelevant or out-dated information. While traditional linear combat operations have typically emphasized the use of technical collection means that are controlled in specialized operational channels (e.g., airborne sensors, signal intelligence collection systems), stability operations in urban areas with dense civilian populations have increasingly shifted emphasis to the collection of human intelligence (HUMINT). In stability operations, every Soldier becomes a potential HUMINT collector as they engage in patrols, cordon and searches, traffic control points, and other activities. Thus, the planning and management of HUMINT collection becomes an important part of daily operations.
- Running Estimate (Staff Estimate)[6] – the staff sections' continuous assessment of current and future operations to determine if the current operation is proceeding according to the Commander's Intent and if future operations are supportable. As noted earlier in Figure 13, the Running Estimate provides the basis for action by developing the fragmentary mental models needed to build the lower portion of the focal knowledge space outlined in Figures 6, 7, and 9. These mental models correspond to the elements of the Running Estimate outlined in FMI 5-0.1: friendly force capabilities, enemy capabilities and intentions, effects of terrain and weather, influence of civilians, and effects of time available. The mental models developed as part of both the IPB process and Running Estimate process highlight relevant causal mechanisms and pathways that allow the staff to subsequently link—in the course of action development and targeting process—specific operational environment objects (e.g., individuals, groups, factions, facilities), with specific effects (e.g., defeat, capture, influence, block, repair), with specific actions

[6] FM 5-0.1 combines the terms "Staff Estimate" (FM 5.0) and "Running Estimate" (FM 6.0) into a single term "Running Estimate."

(e.g., cordon and search, cache raid, traffic control points, negotiation, construction project). At this level of detail, the mental models support the development of associated Measures of Effectiveness (MOE) and Measures of Performance (MOP) that can be used to track and assess operational progress.

- Course of Action Development and Execution during the Course of Action (COA) development and execution process, the commander updates and refines his Commander's Intent and CCIR priorities while the staff continues to translate his intentions into specific actionable knowledge. This knowledge takes the form of both a COA approval, as well as the refinement and prioritization of a set of high priority targets that will be engaged during execution. The development and approval of the COA involves some level of mental war-gaming by the staff as they apply specific proposed actions to their held mental models of the enemy, friendly forces, terrain, weather, civilians, and time. That is, the war-gaming of specific COA options depends directly upon the detailed visualizations of the operational environment currently maintained in the IBP and Current Estimate. Similarly, the targeting process involves an expansion of these same mental models to predict what types of operational environment object-effect-action triads will contribute most effectively to achieving the desired end states articulated in the Commander's Intent and Planning Guidance. This activity is normally carried out by a targeting working group that is chaired by the Fire Support Coordinator and includes expertise drawn from across the different staff sections. Finally, the COA is synchronized across the different warfighting functions reflected in the commander's force.

From a social cognition point of view, the MDMP reflects a collaborative visualization process involving the commander and his supporting staff. This process, conceptually summarized in Figure 14, begins with the receipt of orders, includes an initial planning phase, and then continues in a cyclical pattern of execution-adjustment-execution until either the commander's intent is achieved or there is a significant change in the mission orders.

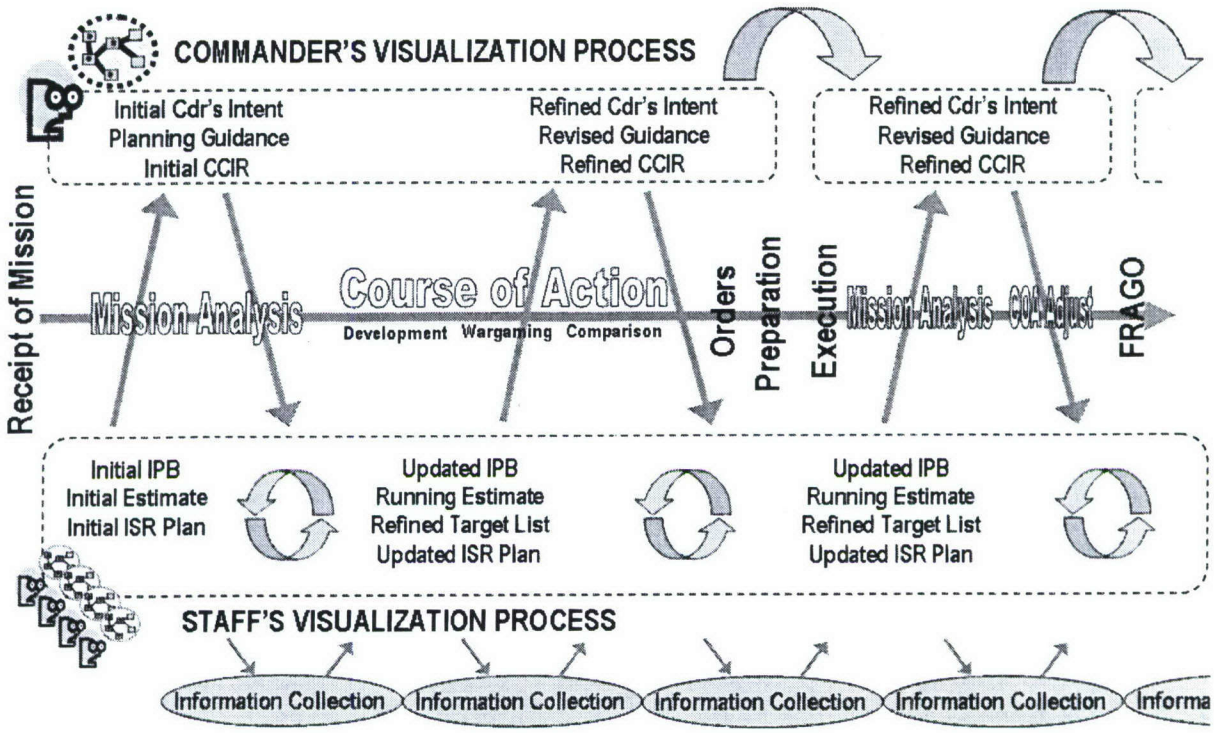

Figure 14. Collaborative Visualization Process Involving both Commander and Staff.

Shown at the top of Figure 14 is the commander's continuing visualization process that produces and maintains his Commander's Intent statement, Planning Guidance, and CCIR set. Complementing this mental activity is the staff's continuing visualization process that produces and maintains the IPB analysis, Current Estimate, and current ISR Plan. From a social perspective, two forms of collaboration are reflected in this overall visualization cycle. The arrows in the middle of the figure indicate collaboration between the commander and his supporting staff. Here, the commander develops and maintains the upper portion of the focal knowledge structure—e.g., the objectives, centers of gravity, lines of operation—while the staff develops and maintains the lower portion of the focal knowledge structure—e.g., the translation of centers of gravity and lines of operation into specific effects and actions along specifically identified causal mechanisms and pathways within the operational environment. Thus, effective vertical collaboration between the commander and his staff is required to complete the overall visualization process. Next, the arrows shown within the staff's visualization process indicate collaboration among the various areas of functional expertise needed to address the different political, military, economic, social, information, and infrastructure (PMESII) aspects of the operational environment.[7] This second form of collaboration—discussed later in greater detail—is more horizontal in nature as the different areas of PMESII expertise come together in specifically focused meetings to address each critical dimension of the commander's problem set.

[7] The acronym "PMESII" is used in joint doctrine to denote the political, military, economic, social, information, and infrastructure dimensions of modern stability operations. However, this term has not been generally adopted in Army doctrinal literature. The acronym is nominally used in this report to reflect the multidimensional complexity of modern stability operations; however, its use should not be construed to indicate doctrinal acceptance of this term.

Transferring Visualization at RIP/TOA. A special aspect of the social process that is somewhat unique to military organizations is the transfer of visualization from one unit to another unit that is replacing it. This occurs at a point known as Relief in Place – Transfer of Authority (RIPTOA). A review of current U.S. Army doctrine reveals little—if any—discussion concerning the RIP/TOA process relative to visualization. Field Manual 3-90 discusses tactics and techniques for RIPTOA, but does so primarily in the context of traditional linear combat operations (Department of the Army, 2001b).

The significance of the RIP/TOA process in stability operations arises from the fact that much of the commander and staff's tacit knowledge of the insurgency and PMESII dynamics of the civilian population is developed from first-hand experience in the AO. Hence, their ability to identify mental models relevant to the situation will usually be limited as they arrive in the AO, and will grow slowly over time as they begin to interact with this environment on a first-hand basis. Initial familiarity with the AO could be significantly enhanced if, as part of the RIP/TOA process, the departing unit initiates steps to systematically transfer their knowledge of the AO to the arriving unit. This, however, represents a special challenge in two respects. First, the two units must overcome both parochial and interpersonal trust barriers—e.g., the tendency for commanders to prefer their own personally-formed visualization, rather than accepting the vision and insights of another commander. Second, most staffs lack a well-developed ontology and language with which to express their tacit and focal knowledge.

Nevertheless, it is essential that the departing unit takes steps to systematically document key aspects of their focal knowledge space and to make this description available to the arriving unit. Here, several knowledge frameworks might serve as a framework for transferring such knowledge: METT-TC, Elements of Operational Design, and the abstraction-decomposition hierarchy of focal knowledge elements depicted in Figure 6. Since much of this process will require significant interaction between the staff officers and their counterparts in the other unit, commanders should allow sufficient time for this socialization process to take place.

Summary of Visualization as a Social Process. At its core, visualization is seen as a cognitive process occurring within the individual. However, at the battalion level, visualization is significantly influenced by a number of social structures, processes, and potential barriers that combine to influence the degree to which the organization is able to achieve shared understanding and unity of purpose. At a social level of analysis, the commander and his supporting staff are seen to play unique and complementary roles in the visualization process. The commander establishes the operational framework for this process through the articulation of Commander's Intent, Commander's Planning Guidance, and CCIR. The staff translates this vision into causal mechanisms and pathways, operational environment objects, and actions through the documentation of the IPB, ISR Plan, Running Estimate, and COA Briefing. This more detailed knowledge is developed through the collaboration of specific areas of staff expertise across the commander's personal staff, coordinating staff, and special staff that focus on specific aspects of the commander's visualization space. The effective working of these groups in creating shared understanding and unity of purpose requires the deliberate minimization of specific types of cognitive, social, organizational, and technical collaboration barriers. Finally, military units—particularly those engaged in stability operations—have the unique challenge of transferring locally developed tacit knowledge from one unit to another at

the point of RIP/TOA. Thus, for the purposes of visualization skill development, it is important to look beyond the individual and to address those types of management skills needed to organize and maintain this social process. Specifically, these skills relate to the ability of the commander—together with his personal, coordinating, and special staff officers to synchronize the elements and linkages of the visualization space in each of several ways:

- Vertically across the different levels of thinking and assessment conducted by the commander and his staff,
- Horizontally across the different METT-TC dimensions of the operational environment,
- Chronologically across both short-term actions and their long-terms consequences for mission objectives, and
- Socially across the different stakeholders and functional experts relevant to the commander's area of operation.

These different synchronization dimensions are illustrated in Figure 15. Vertical synchronization operates between the commander and his supporting staff. It serves to insure that the staff's development of detailed system models, relevant operational environment objects, purposeful actions, required resources, and timing are consistent with the purpose, focus, and broad system effects outlined by the commander. In terms of the MDMP, vertical synchronization of the visualization space is accomplished through commander/staff interaction in order to that the staff's IPB products, running estimates, and target folders are consistent with the commander's intent, CCIRs, and planning guidance.

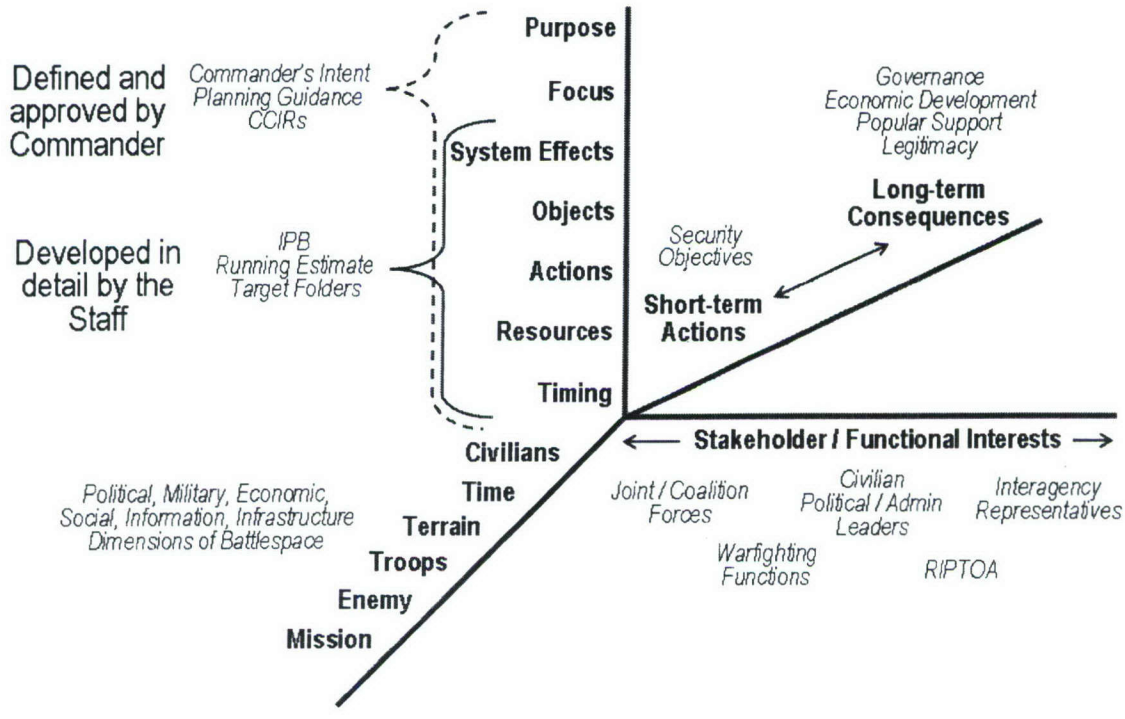

Figure 15. Visualization Space Synchronization.

Horizontal synchronization operates across the different dimensions of the commander's problem space. Doctrinally, horizontal synchronization insures that each of the METT-TC dimensions is appropriately considered in developing the visualization space. More specifically in stability operations, it implies that the visualization process will give appropriate consideration to the relevant political, military, economic, social, information, and infrastructure elements of the operational environment and their key interactions.

Chronological synchronization operates across different time horizons and insures that proper consideration is given to the long-term consequences of military actions. Specifically within stability operations, short-term military actions taken to achieve security objectives must be reconciled with their potential impact on long-term governance, economic development, popular support, and legitimacy objectives.

Finally, social synchronization recognizes the need for unity of purpose and operates across different stakeholder and functional interests. Within the commander's immediate chain of command, this includes synchronization of the visualization space across warfighting functions and unit transfers of authority. Beyond the immediate chain of command, this includes synchronization of the visualization space with the perspectives of other joint/coalition military forces, other government agencies, and with key civilian political and administrative leaders with whom the commander is attempting to co-opt.

Ecological Level of Analysis

A third level of analysis of the visualization process involves the manner in which the mental development of understanding is influenced by enactment of the operational environment. That is, visualization is not entirely a passive process of fitting available information into an experience-based framework of interpretation. Rather, there are times when organizations actively engage their operational environment to both (1) shape real world events and states in conformance with the organization's vision and (2) probe and reveal additional aspects of the operational environment that can be subsequently exploited for advantage. An organization's active engagement (i.e., enactment) of the operational environment is a particularly relevant strategy to pursue in either the "Complex" or "Chaos" levels of disorder defined earlier in Figure 9 – two levels of disorder emphasized in stability operations. Consequently, it is useful to understand how enactment of the operational environment can serve to support the commander's visualization process.

Shaping and Probing Actions Illustrated. Considered at this level of analysis are several types of actions that might be taken by an organization. Figure 16 illustrates the first type of action—one taken by a battalion to shape its operational environment and bring it closer to the state envisioned by the commander.

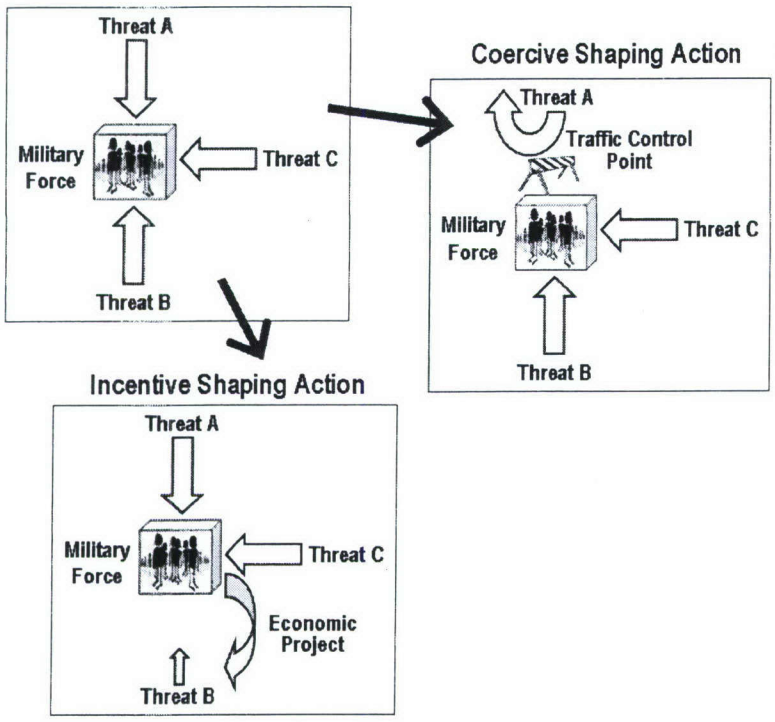

Figure 16. Illustration of Shaping Actions.

In this example, a commander has been given the mission of stabilizing his assigned AO. In the first box shown in the upper left, the commander realizes that his operation is being threatened by three distinctive insurgent groups. Threat A consists of foreign terrorists being infiltrated into his AO. Threat B consists of local freedom fighters who are generally displeased with the military occupation. Threat C consists of criminal elements that are operating within the AO purely for material gain. Shown in the second box to the right is the effect of taking a coercive shaping action against Threat A—e.g., the establishment of traffic control points that restrict the movement of foreign terrorists into the AO. Shown in the lower box is the effect of taking an incentive action against Threat B—e.g., providing work for local unemployed family members who would otherwise be hired by the foreign terrorists to conduct acts of aggression against the U.S. forces. In either case, the use of these shaping actions serve to reduce one of the threats and move the commander's AO toward his envisioned state of stability—thus allowing him to focus greater attention on other mission objectives.

Illustrated in Figure 17 are two additional types of actions that allow a commander to (1) develop a more detailed understanding of his operational situation and (2) subsequently exploit this newly discovered knowledge.

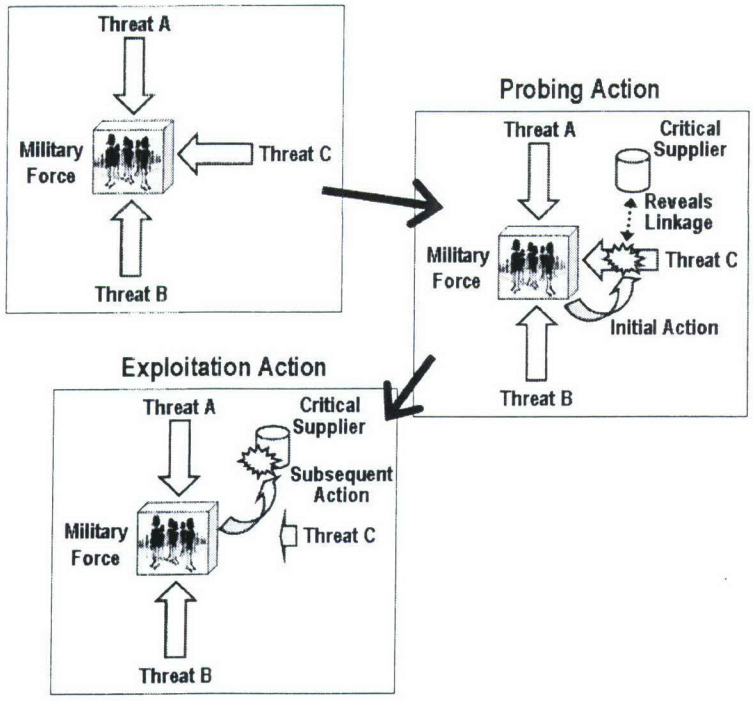

Figure 17. Illustration of Probing and Exploitation Actions.

As in the previous illustration, the commander realizes that his mission is being threatened by three distinctive insurgent groups. Threat A consists of foreign terrorists being infiltrated into his AO. Threat B consists of local freedom fighters who are generally displeased with the military occupation. Threat C consists of criminal elements that are operating within the AO purely for material gain. In this illustration, however, the commander executes a probing operation against Threat C in order to develop further intelligence on a locally organized criminal cell in his AO—e.g., he conducts a cordon and search against a suspected safe house. Through careful collection and analysis of documents found in the targeted safe house, his S-2 section discovers an important linkage between the criminal cell and a top-level supplier of weapons and funding. Then, in a subsequent exploitation action, he conducts a raid against the suspected supplier, thus cutting off support for the criminal cell. In this example, the probing action serves to expand his visualization of a specific part of his problem space, while the exploitation action capitalizes on the newly discovered elements of actionable knowledge.

Assessment and Discovery – Aspects of Visualization during Execution. The previous illustrations show how the commander's visualization process can be influenced by enactment of the operational environment. That is, visualization shapes action and actions subsequently shape the visualization process in a continuous manner. Given this interaction, it is important to consider how this process can be managed within the military unit's overall battle rhythm. To address this issue, we turn attention to the execution phase of the MDMP defined in FM 5-0 as part of the commander's repeated cycle of "Plan – Prepare – Execute – Assess."

One aspect of visualization during execution involves the accurate assessment of operational progress. As defined in FMI 5-0.1:

> Assessment is the continuous monitoring and evaluation of the current situation and progress of an operation. It involves deliberately comparing forecasted outcomes to actual events to determine the overall effectiveness of force employment. Commanders and staffs base assessment on their situational understanding. They achieve and maintain situational understanding to identify opportunities for more effective mission accomplishment, threats to the force, and gaps in information (p. 1-14).
>
> Many aspects of military operations are quantifiable. Examples include movement rates, fuel consumption, and weapons effects. While not easy, assessing physical aspects of operations can be straightforward. However, the dynamic interactions among friendly forces, adaptable enemies, and populations make assessing many aspects of operations difficult. This is especially true of operations in which stability and reconstruction operations predominate. For example, assessing the results of planned actions to change human behavior is very challenging. In these instances, assessment relies on understanding trends and indicators over time to make judgments concerning the success of given actions (p. 5-1).

The quality and effectiveness of the assessment process during execution depends directly upon the degree to which the commander's visualization has been (1) clearly defined in terms of the underlying mental models currently activated within his focal knowledge space and (2) clearly articulated to his staff in terms of key knowledge elements. Key knowledge elements include:

- Identification of decisive points.
- Causal mechanisms and pathways deemed highly relevant to the desired effects and actions outlined in the approved COA.
- Critical assumptions and unknowns addressed in the current list of CCIRs.
- Forecasted events and states derived from the first three types of knowledge elements.

Regarding the development of CCIRs, FMI 5-0.1 offers a nominal set of questions that can be used to identify areas of uncertainty within the commander's visualization that critically impact on the success of the mission:

- Can the force achieve the commander's intent?
- Where is the enemy? Doing what? How?
- Where are friendly forces? Doing what? How?
- What is the enemy's force posture now? What will it be at some specified decision point in the future?
- Where will the friendly force be at this decision time?
- What are the enemy force's problems? How can the force exploit them?
- What are the friendly force's problems? How can they be corrected?
- What are the friendly force's opportunities? How can they be exploited?
- Are any changes needed in the concept of operations? Task organization? Mission?
- What is the disposition of the civilian population? What impact do they have on the operation? What impact does the operation have on the civilian population?

In addition to developing CCIRs, the commander's visualization is also used to develop a clearly defined set of Measures of Effectiveness (MOE). Again according to FMI 5-0.1:

> A measure of effectiveness is a criterion used to assess changes in system behavior, capability, or operational environment that is tied to measuring the attainment of an end state, achievement of an objective, or creation of an effect. The MOEs focus on the results or consequences of friendly actions taken. They answer the question, Is the force doing the right things, or are additional or alternative actions required? Often an effect cannot be measured directly. If direct measurement is not possible, then indicators of achieving the effect are measured. Staffs then apply analysis and judgment to develop conclusions about achieving the effect. Measuring indirectly requires great care in selecting and measuring indicators (p. 5-5).

The MOEs flow from the underlying mental models currently activated within the commander's focal knowledge space and help him to understand whether or not his visualization is being realized. Accordingly, they must have the following characteristics in order to be useful for assessing progress: measurable, discrete, relevant, and responsive.

- The MOEs must be measurable in either a quantitative or qualitative fashion. Quantitative measures are preferred, but not always possible. Where qualitative measures are used, they must be tied to clearly defined criteria that can be unambiguously understood by the staff.
- The MOEs must be discrete—i.e., linked to a distinct aspect of the commander's envisioned problem space. The number of MOEs must be limited in order to avoid over tasking the staff's ability to monitor and assess them and the commander's ability to absorb and understand their significance.
- The MOEs must be relevant to the essential parts of the commander's visualization. Development of relevant MOEs is usually difficult and depends upon the degree to which the mental models underlying the commander's focal knowledge space have been clearly defined and articulated in an unambiguous manner to the staff. One caution is that aspects of the operation that are easily quantified are not always highly relevant to measuring operational progress. To be relevant, an MOE must be linked to specific causal mechanisms and pathways identified in each of the PMESII areas.
- The MOEs must be responsive. That is, they must be capable of quickly revealing important changes in the situation. The MOE responsiveness is required in order for the commander to operate inside of the enemy's decision cycle.

A second aspect of visualization during execution involves the recognition of variances. As defined by FMI 5-0.1:

> A variance is a difference between the actual situation during an operation and what the plan forecasted the situation would be at that time or event (FM 6-0). Staffs ensure information systems display relevant information that allows them to identify variances. When a variance emerges, the commander and staff evaluate it. If necessary, the staff updates its running estimates and recommends a course of action (COA) to the

commander, who directs the necessary action. There are two forms of variances: opportunities and threats…

The first form of variance is an opportunity to accomplish the mission more effectively. Opportunities result from forecasted or unexpected successes. When they recognize an opportunity, commanders alter the order to exploit it if the change achieves the end state without incurring unacceptable risk…

The second form of variance is a threat to mission accomplishment or survival of the force. When a threat is recognized, the commander adjusts the order to eliminate the enemy advantage, restore the friendly advantage, and regain the initiative…

Victory in battle requires commanders to recognize and evaluate opportunities and threats—current and projected—in time to direct effective actions that exploit or counter them. Commanders use their visualization based on the common operational picture as their primary evaluation method. Staffs use their running estimates, derived from their understanding of the common operational picture, to evaluate the situation and provide recommendations (p. 4-3).

The recognition of variances during execution requires the commander and his supporting staff to have a clearly articulated forecast of key expected events and conditions. These forecasts must be conceptually grounded in the structure and linkages defined within the commander's focal knowledge space (see Figure 6). At the same time, the military unit's system of responding to CCIRs must have a clear understanding of the relevance of each CCIR to validating, adapting, or revising the commander's focal knowledge space. In this manner, the system will be capable of immediately channeling significant discoveries and facts to the attention of the commander, while minimizing the likelihood of information overload. The FMI 5-0.1 provides an example (illustrated in Figure 18) of the types of variances that might arise within each warfighting function area.

Variances serve as decision indicators for the commander. They can potentially trigger changes to the currently approved COA, the targeting plan, and the ISR plan. At a more fundamental level, variances serve to refine the commander's envision problem space and/or shift his immediate attention from one aspect of focal knowledge to another. From a visualization management perspective, variances act to shift the focus and application of limited mental resources from one set of issues to another. Hence, the military unit's system for generating variance assessments must be carefully grounded in a shared understanding between the commander and his supporting staff.

The general process to be managed is depicted in Figure 19. As shown in this figure, the commander—or, more likely, a designated officer such as the XO or S-3—must attend to two aspects of knowledge management during execution: discovery and adjustment (shown at the top of the figure) and progress assessment (shown at the bottom of the figure). As part of the discovery and adjustment process, the staff monitors key task accomplishment/mission MOEs and other feedback from the current execution cycle to determine if and where a significant variance has occurred in the operation. Upon detection of a significant variance, the staff revises

the Current Estimate, Intelligence Preparation of the Battlefield (IPB), and/or targeting list, as appropriate, to reflect the change. At the same time, the commander revises his focal knowledge space to reflect the addition of a new or altered mental model corresponding to the area of the variance. These actions, in turn, are likely to lead to the development of a fragmentary order (FRAGO) that modifies some aspect of the unit's ongoing sequence of operations. For example, as illustrated in the example shown in Figure 19, the discovery of an important linkage between a criminal cell and a top-level supplier of weapons and funding might trigger the refocusing of unit combat power against this individual.

Intelligence	• Identification of enemy main effort. • Identification of enemy reserves or counterattack. • Indications of unexpected enemy action or preparation. • Identification of an IR. • Insertion of manned surveillance teams.	• UAS launch. • Identification of HPT/HVT. • Answer to a PIR. • Enemy electronic attack use. • Enemy rotary-wing or UAS use. • Identification of threats from within civilian population.
Movement and Maneuver	• Success or failure of a subordinate unit task. • Success or failure in breaching operations. • Capture of significant numbers of EPWs, enemy CPs, supply points, or artillery units.	• Modification of an ACM. • Answer to an FFIR. • Numbers of refugees sufficient to affect friendly operations. • Damages to civilian infrastructure affecting friendly mobility.
Fires	• Receipt of an air tasking order. • Battle damage assessment results. • Unplanned repositioning of firing units. • Success or lack thereof in offensive information operations.	• Identification of an IR. • Execution of planned fires. • Modification of a FSCM. • Effective enemy counterfire. • Identification of HPT/HVT.
Sustainment	• Significant loss of capability in any class of supply. • Identification of significant incidences of disease and nonbattle injury casualties. • Mass casualties. • Receipt of significant resupply. • Contact on a supply route.	• Civilian mass casualty event beyond capability of HN resources. • Identification of significant shortage in any class of supply. • Aeromedical evacuation launch. • Answer to an FFIR. • Changes in availability of HN support.
Protection	• NBC 1 report or other indicators of enemy CBRNE use. • Report or other indicators of enemy improvised explosive device use. • Indicators of coordinated enemy actions against friendly forces. • Identification of threat to base or sustainment facilities.	• Identification of threats to communications or computer systems. • Reports of enemy targeting critical HN infrastructure. • Increased criminal activity in a given sector.
Command and Control	• Answer to a CCIR. • Identification of an IR. • Loss of contact with a CP or commander.	• Jamming. • Receipt of a fragmentary order or warning order from higher headquarters.

ACM	airspace control measure	HN	host nation
CBRNE	chemical, biological, radiological, nuclear, and high-explosives	HPT	high-priority target
		HVT	high-value target
CCIR	commander's critical information requirement	IR	information requirement
CP	command post	NBC	nuclear, biological, and chemical
EPW	enemy prisoner of war	PIR	priority intelligence requirement
FFIR	friendly forces information requirement	UAS	unmanned aircraft system
FSCM	fire support coordinating measure		

Figure 18. Example Types of Variances Organized by Warfighting Function.

At the same time, the staff employs the approved MOEs to monitor operational progress. Over the course of several operational cycles, the staff tracks and documents critical MOEs and task accomplishment as part of its Current Estimate. This tracking is important for two reasons.

First, it keeps the focus of attention on the overall desired end state articulated in the Commander's Intent. This can be particularly important in stability operations where progress is made slowly over time and in small increments. Keeping a constant eye on measures of overall progress help to maintain the unity of purpose reflected in the commander's visualization. Second, the tracking of various MOEs provides the opportunity to reassess operational priorities—i.e., determine if a shift of emphasis or resources is needed in response to a particular aspect of the operation lagging behind the others.

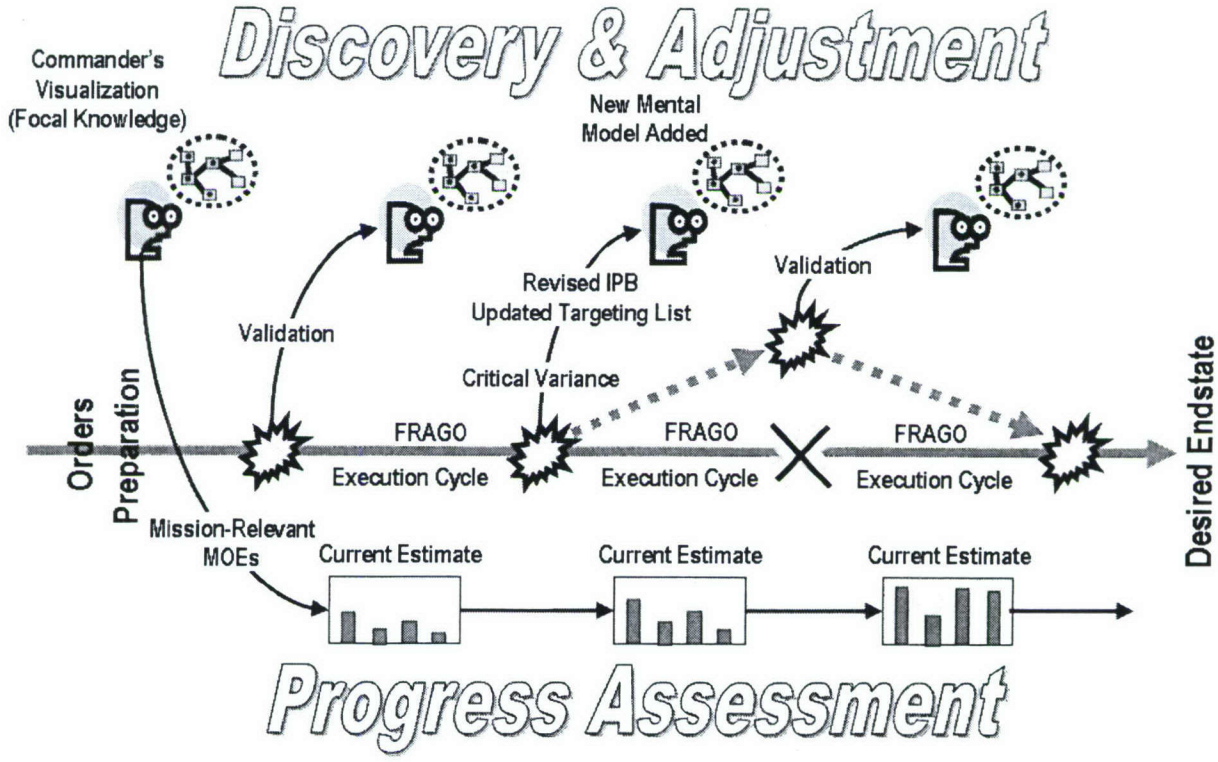

Figure 19. Managing the Discovery and Assessment Process during Execution.

Summary of Visualization as an Ecological Process. As discussed in the preceding section, visualization involves the enactment of the operational environment in several ways: shaping actions and probing/exploitation actions. From a battalion visualization perspective, shaping actions serve to conform the commander's operational environment to his envisioned problem space. They also serve to reduce the number of unknowns and risks along key lines of operation. Probing actions serve to illuminate additional elements and linkages within the visualization space that can be subsequently exploited for operational advantage. Probing actions are particularly useful in complex operational environments where the commander is unable to apply a known battle calculus to develop portions of the visualization space. However, for probing actions to be effective and productive, they must be combined with deliberate analysis to identify emerging trends and patterns.

From a training point of view, the ecological aspects of visualization require the commander to establish meaningful MOE. The MOE focus on the results and consequences of unit actions with respect to the mission objectives established by the commander. They assist the

commander in determining if these actions are appropriate, or if different or alternative actions are required. MOE flow directly from the structure and content of the visualization space and serve to visibly link the outcome of actions with the system effects, focus, and purpose established by the commander. By contrast, measures of performance typically address the relationship of actions with resources and timing.

At the same time, the commander must also key his CCIR and within PIR to areas of uncertainty, ambiguity, and equivocality reflected in the visualization space. Focused information collection and interpretation activities shaped by the CCIR and within PIR will assist the commander in further refining the visualization space in an efficient and purposeful manner.

Development of the visualization space is typically associated with operational planning within the MDMP. However, this same knowledge serves an important role during execution as the commander attempts to adjust his operations to the evolving and emergent nature of the operational environment. During execution, effective visualization enables the commander to track key problem elements and lines of operation over time to identify meaning patterns or trends and to maintain unity of purpose with respect to long-term mission objectives. This involves the development of a Running Estimate, the staff's continuous assessment of current and future operations to determine if (1) the current operation is proceeding according to the Commander's Intent and (2) future operations are supportable. Good documentation of the visualization space allows the Commander to identify key variances with respect to forecasted events and states, and to appropriately adjust his operational actions to maintain unity of purpose. Without constant reference to the content and structure of the visualization space, the Commander is apt to become mentally absorbed in moment-to-moment operations and lose sight of the bigger picture reflected in the purpose, focus, and system effects shaping the overall mission. Maintenance of the visualization space is reflected in (1) the Commander's continual adjustment of his planning guidance and (2) the staff's continual refinement of the IPB, running estimate, and target folders.

Finally, training must address the commander's purposeful enactment of the operational environment through shaping actions and probing actions. Here, the commander must understand the role and use of shaping and probing actions in conjunction with his visualization space. Both types of actions consume limited combat resources; hence, they must be judiciously guided by the content and structure of his visualization. Shaping actions serve to conform the operational environment to his constructed picture while probing actions allow him to reveal and illuminate key structures and linkages within the operational environment. At the same time, visualization involves positioning and focusing the unit's battle rhythm to enable rapid discovery and exploitation of newly revealed functional relationships within the operational environment that sustain an adversary, influence a civilian population or host nation, or affect some other relevant METT-TC factor. The guided use of shaping and probing actions together with deliberate and focused analysis enable the commander to effectively adapt his operations to a complex and dynamic operational environment—thus demonstrating a close, interactive relationship between knowledge creation and action-taking.

Interview Observations and Findings

During the period of February through June of 2006, a series of interviews were conducted with 25 military officers to investigate their real-world experiences with visualization. Each of these interviews lasted approximately two hours, was preceded by providing each participant with a read-ahead description of the potential skill areas involved in visualization (Appendix A), and followed a protocol outline (Appendix B). Each interview was recorded and subsequently analyzed in terms of key processes and mental structures involved in effective visualization. The initial set of participants (major through colonel) was identified based on relevant command experience (Battalion) or recent staff experience (XO or S-3 within either a battalion or brigade staff) in either Afghanistan or Iraq. Following these interviews, additional interviews were conducted with Command and General Staff College (CGSC) instructors and Fellows from the U.S. Army's School for Advanced Military Studies (SAMS) to validate the initial findings and to further explore specific issues. A final interview was conducted with Lieutenant General (retired) Paul Funk to again validate the other interview findings and provide further depth of analysis.

Initial Interview Findings

A review of interviews conducted with field officers with recent combat experience revealed a number of "lessons learned" that were primarily relevant to the type of stability operations being conducted in Afghanistan and Iraq:

- The civilian population is the center of gravity in stability operations, with a key visualization challenge being the non-lethal lines of operation that serve to influence this center of gravity.
- The fluid nature of stability operations, coupled with the presence of multiple stakeholders within the operational environment, gives rise to the need for negotiation skills. This requires the command group to visualize the interaction of the various elements and dimensions within the operational environment.
- Stability operations involve both immediate timelines (e.g., cordon and searches, raids, Quick Reaction Force actions) and long-term timelines (e.g., building and integrating Iraqi Army forces into security operation, restoring local infrastructure, establishing a legitimate governance process). Thus, another visualization challenge is the ability to mentally reconcile these often competing actions, and to identify and understand negative second-order consequences one set of actions might have on another.
- Given the steady-state nature of stability operations, command groups tend to sometimes lose focus on the need to do formal planning—opting instead to operate off of a series of FRAGOs and "templated" operations for cordon and searches, raids, etc. Thus, another visualization challenge is the need to maintain a running estimate of the overall situation, to maintain a focus on long-term end state goals, and to keep track of progress being made by a unit as it completes its rotation.
- There are lots of moving parts within a unit's battle rhythm that impact on visualization—including the continual generation of actionable intelligence from within the unit itself, the need to build and maintain understanding of the key players (both local civilians and insurgency cells) and their social linkages, and the need to build and

maintain both lethal and non-lethal target folders. Only a small fraction of this knowledge base is visualized in graphical form, with much of it occurring in the form of after-action review (AAR) summaries, link-node diagrams, prioritized lists, ancillary documents and notes on key individuals, statistical charts showing operational trends, timeline charts, etc. This codified knowledge is significantly supplemented by tacit knowledge gained from personal experience—most of which accumulates during the current rotation since prior combat experience is often not relevant. Thus, the term "visualization" is more correctly interpreted as being an internal mental model that can take many forms—rather than a picture or drawing.

A comparison of these findings with the review of doctrinal and psychological literature outlined in the earlier sections of this report revealed that many of the "lessons learned" reported by the interviewees have already been documented in the existing counterinsurgency literature. Many of the interview participants also revealed that they did not have specific training on many of the issues. Thus, it was not surprising that they arrived in theater without a solid mental framework within which to interpret their operational environment observations—a framework that they slowly acquired only through "on the job training" as they attempted to cope with unfolding events.

There also seemed to be little reported application of the visualization frameworks already provided by Army doctrine. These included METT-TC and the elements of operational design. Such mnemonics and dimension lists reflect a systems approach to visualization, although their specific interpretation varies with each operational environment. They were, however, adept at developing new mnemonics such as sewer, water, electricity, academics, trash, medical, and security (SWEAT-MS) and PMESII to guide their visualization process within the specific environment of Iraq or Afghanistan. The Army's current doctrine written in FM 6-0 (2003), covers all the elements of these mnemonics in METT-TC under the area of "civilian considerations," with the military being covered under the area of "enemy." The current Army doctrinal mnemonic that covers these elements is ASCOPE.

There also seemed to be little attention paid to conducting an MDMP—or, at least, understanding the type of knowledge and understanding produced at each step in the MDMP. Probably most significantly, there seemed to be little real appreciation of the mission analysis step as one in which the command group collaboratively develops a shared understanding of the operational problem space. This is particularly important in stability operations where (1) the specifics of the problem space can vary from area to area or month to month and (2) there does not exist a familiar "battle calculus" or known set of mental models that can be applied to frame understanding. Thus, correctly defining the problem space is critical to mission success.

Finally, it was observed that the traditional MDMP is geared toward a linear, contiguous type of operation—usually one in which there is a rapid military victory. Little is understood about how the MDMP ought to be modified to accommodate the long-term, slow-rate-of-progress nature of stability operations. Lacking such an understanding, the tendency is to abandon the MDMP and employ more of an ad hoc planning rhythm. One implication of this is officers might see mission analysis as an "up-front" rote planning task that merely serves to

develop a restated mission paragraph—rather than an on-going process that needs to be consciously or deliberately updated on a continuing basis.

Validation and Refinement of Findings

Given these insights, we went into the series of interviews at Fort Leavenworth with a focus on validating or reinforcing these ideas with both the SAMS fellows and several tactics instructors from the Command and General Staff College. All of these interviewees had recent combat experience in Iraq, but now they were in a position where they could deliberately reflect on these experiences and their implications for leader development. Without exception, this set of interviews confirmed the insights we had already developed, while adding reinforcing detail. For example, one officer reported that he had never read any counterinsurgency literature prior to his rotation in Iraq and that—even by the end of his rotation—he did not understand the importance of winning the hearts and minds of the Iraqi people. In another case, two of the instructors identified yet another mnemonic device for visualizing the required sequence of tactical actions: gain and maintain contact, fix the adversary, disrupt, maneuver, follow through. Several of the SAMS fellows and CGSC instructors noted the importance of elements of operational design and argued that some needed to be extended down to the tactical level of visualization in stability operations (current doctrine associates these elements primarily with operational level visualization).

In the interview with Lieutenant General (retired) Paul Funk, he concurred with our initial findings and emphasized the importance of doctrine in framing the visualization process. In short, doctrine provides the "common ground" of understanding that facilitates the collaborative development of shared vision. According to General Funk, there is a recurrent tendency for (1) commanders to discount military history lessons as being relevant to current operations and (2) officers to pay lip service to traditional concepts such as METT-TC, elements of operational design, MDMP, etc. That is, they treat them as rote procedural devices, rather than understanding the logic behind their ability to structure a commander's thinking process.

Taking all of these findings together, it was concluded that battalion visualization training development ought to be shaped and focused in two areas: (1) knowledge structure and (2) knowledge creation process. Structure deals with the shape and form of knowledge created in the visualization process, whereas process focuses on the tasks, interactions, and relationships required to construct and maintain this knowledge in a dynamic and evolving environment. More specifically, the training should be built on the following ideas:

- *Knowledge Structure*. Visualization is purposefully organized around a hierarchical set of knowledge elements and linkages that relate intent to action. These knowledge elements and their linkages evolve from different levels of thinking that address purpose, focus, system effects, objects, actions, resources, and timing. Together, these knowledge elements enable the Commander to paint a picture of how he will move the operational environment from its current state to some desired end state conditions. Army doctrine (specifically, METT-TC and the elements of operational design) serves to guide and shape the structuring of knowledge at both operational and tactical levels of command; however, application of these frameworks involves the commander's creative application

of the art of warfare—i.e., they cannot be applied in rote, "cookbook" fashion. The training requirement here should focus on how each of these doctrinal frameworks is to be interpreted in a non-linear, non-contiguous stability operations environment. For example, "terrain" includes visualization of the cultural, social, and political terrain, as well as the geographic terrain. "Troops" include not only the unit's organic combat resources, but also other assets such as the host nation army, other government agencies, joint assets, etc., that require negotiation and personal relationships to develop.

- *Knowledge Creation Process.* The Army's MDMP provides a logical process framework for unfolding the visualization process from high level intent down to specific directed actions. However, training should focus on teaching the MDMP from a knowledge management perspective—i.e., get officers to understand how the process builds the visualization space relevant to an on-going operation. Emphasis should be placed on illustrating how the MDMP is adapted to stability operations. At its core, visualization reflects a mental process of linking intent with action. However, as discussed earlier in this report, effective visualization requires deliberate collaboration between the Commander, his supporting staff, and other relevant stakeholders within his area of operation. At the same time, the Commander must understand the close, interactive relationship between knowledge creation and action-taking. Together, these different aspects of visualization require that training address specific skill areas at three levels: cognitive, social, and ecological.

Identified Training Areas

A synthesis of the literature review findings and interview findings resulted in the identification of 11 skill areas. These skill areas address various cognitive, social, and ecological aspects of developing, maintaining, and exploiting an actionable knowledge structure referred to in this project as the Commander's visualization space. Figure 20 arranges these skill areas in terms of four aspects of visualization: (1) building the visualization, (2) synchronizing the visualization, (3) assessing the visualization, and (4) exploiting the visualization.

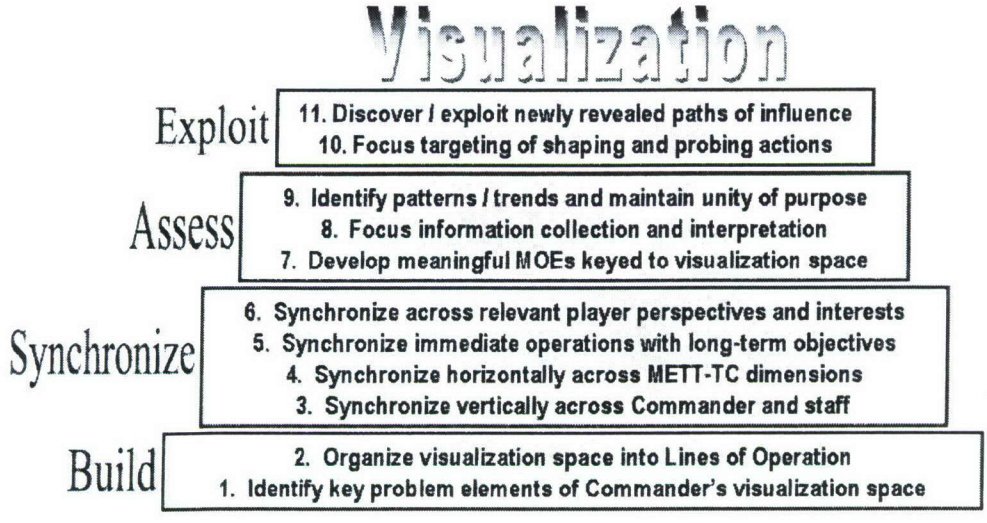

Figure 20. Visualization Skill Areas.

Taken together, visualization skills address the ability of the commander, collaboratively supported by his staff, to build, synchronize, assess, and exploit an evolving understanding (Commander's visualization space) of the operational situation with respect to assigned mission objectives. The visualization space links action with intent through the balanced application of experience-based intuition and deliberate reasoning. The process is structurally framed by a common doctrinal language in order to facilitate shared understanding. The content of the envisioned problem space is matched to the dimensions and levels of complexity reflected in the operational situation. The process is continuously adjusted throughout the planning and execution rhythm in response to a thinking and unpredictable adversary, as well as to newly revealed aspects of the operational environment. Ultimately, it is the visualization process that guides and supports the broader military decision-making process of the unit.

In reality, the visualization skill areas are applied in an integrated, seamless manner across the planning and execution cycle. However, for the purpose of training focus, they are distinctly identified and organized into the pyramidal structure shown in Figure 20, with skill competency at the lower level of the pyramid providing the foundation for training higher level skill areas. This hierarchical structure primarily reflects a scaffold-type learning process and is not intended to imply either order of skill area importance or sequence of skill performance in real life.

The following section of the report provides a description of each identified skill area, together with a summarization of the training target and performance criteria. Training for each skill should provide both individual and collective training opportunities.

Skill Area 1 – Identify Key Problem Elements of the Commander's Visualization Space

The MDMP is framed and guided by the commander's visualization space. Structurally, the visualization space reflects the logical association of intent with action. At an abstract level of description, the visualization space begins with a delineation of the unit's assigned mission that characterizes the purpose of the operation. In turn, each mission is articulated in terms of a set of tasks that translate purpose into desired mission accomplishment. From the commander's understanding of the operational environment, he could identify one or more decisive points or centers of gravity that logically focus attention on specific aspects of the adversary, civilian population, or other feature of the operational environment thought to represent a key point of influence. Army doctrine defines decisive point as a place, key event, or enabling system that allows commanders to gain a marked advantage over an enemy and greatly influence the outcome of an operation. Joint doctrine defines center of gravity as the set of characteristics, capabilities, and sources of power from which a system derives its moral or physical strength, freedom of action, and will to act. The commander's broad vision of the operation is complemented by the analytical work of the staff. A major challenge for the staff is the decomposition of abstract centers of gravity into specific operational environment nodes and links that provide concrete definition to the intended points of influence. In general, this system-of-systems analysis must analytically consider each of the METT-TC and under the area of "civilian considerations" ASCOPE factors in order to identify specific influence mechanisms and pathways, and to associate these pathways and mechanisms with specific operational environment nodes (objects, events, etc.) and specific types of lethal and non-lethal effects. For stability operations, key nodes and links can extend across a variety of political, military, economic, social, information, and infrastructure dimensions of the operational environment—thus requiring a wide range of functional expertise. Finally, the staff completes the structure of the visualization space by identifying the specific actions, required resources, and timing of application necessary to achieve the specific effects against each operational environment node.

The upper (more abstract) level of the visualization space is initially developed as an internal mental structure (defined as focal knowledge) through the application of personal experience and training (tacit knowledge), operational principles (historical lessons learned), and doctrinal considerations (codified guidance). This internal mental process involves the triggering and validation of situation-appropriate mental models (frames) that provide a framework for interpreting available information and data. The triggering of specific mental models depends largely upon the ability of the commander and staff to detect and recognize the significance of specific cues from the operational environment. Additionally, mental models are validated through the instantiation of critical feature slots with data/information gathered from the unit's information environment. For this knowledge to be useful as guidance, key elements of the visualization space must be externally documented and shared in the form of Commander's Intent and Commander's Planning Guidance. Much of the staff's complementary visualization is more concrete in nature, is more highly driven by a precise calculus or rule set, and relies upon the effective integration of relevant functional expertise. Hence, it is developed through collaborative analysis and documented in the form of the Intelligence Preparation of the Battlefield (IPB) and the Running Estimate. Both contributions to the visualization—the commander's articulation of purpose and focus and the staff's articulation of systems effects,

objects, actions, resources, and timing—are necessary to form a complete logical association of intent with action.

Training Target/Performance Criteria

- Degree to which the commander and staff detect and interpret relevant triggering cues from the unit's information environment.
- Degree to which the elements of the visualization space are appropriately identified using the relationship between the elements of METT-TC and operational design that link purpose, focus, system effects, objects, actions, resources, and timing across the relevant dimensions of the operational environment.
- Degree to which the elements of the visualization space are identified using commonly understood doctrinal language and mnemonic devices.
- Degree to which the commander and staff validate the mental models underlying the visualization space definition through the instantiation of their critical feature slots.

Skill Area 2 – Organize the problem elements into a plan of action to account for higher's intent and the mission objective

In order for the visualization space to be easily comprehended, the logical association pathways extending from abstract statements of intent down to the concrete pairing of actions with operational environment objects must be mentally organized along either logical or physical lines of operation. Lines of operation provide a framework for shared understanding of how a sequence of operations and action will move a specific aspect of the operational environment from its current state to some desired end state. Physical lines of operation define the directional orientation of the force in time and space in relation to the adversary. They connect a series of decisive points that, over time, lead to the control of a geographic area or adversary force. Logical lines of operation associate mission/end state and course of action with a series of system effects, objects, and actions over time where positional reference to an adversary has little or no meaning. Logical lines of operations are frequently used in stability operations to address the following complementary aspects: combat operations, regional security, civil security, civil control, and civil action (reconstruction or restoration of essential services, and governance).

During execution, lines of operation provide a framework for assessing the need for operational adjustments at decisive points. For example, commanders might gain an intermediate objective in some unexpected manner, encounter an unexpected obstacle or threat, or discover a newly revealed influence mechanism or pathway that can be exploited. In such cases, the line of operation definition provides a mental framework for assessing the following types of questions: Does the success, obstacle, or discovery generate opportunities that more easily accomplish the objectives? Does it suggest other lines of operations? Does it cause a change in overall intent? Should the force transition to a sequel? Should the force accelerate or decelerate the phasing of the operation?

Well-defined lines of operation focus on distinct aspects of the overall operation and include the following elements of actionable knowledge in order to effectively guide the

commander's decision process and the staff's supportive tracking and analysis activities during execution:

- Logical purpose of the line of operation, expressed in terms of mission objective.
- Logical focus of the line of operation, expressed in terms of a desired end state, a relevant center of gravity, and a specific supporting influence mechanism or pathway (e.g., regional/civil security, governance).
- Identified obstacles or threats that must be overcome or marginalized in order to influence the center of gravity and decisive points in some prescribed manner.
- The type of effect(s) or influence to be achieved against the center of gravity and/or identified decisive points.
- Decisive points, defined in terms of specific operational environment states or conditions, represent key opportunities for assessing and redirecting the unit's operations.
- Culminating points that represent the point at which the desired end state is considered to be achieved.
- The weight or emphasis, defined in terms of resource commitment priorities, committed to the line of operation relative to other unit's tasks and responsibilities.

While lines of operation have been traditionally defined at an operational—rather than tactical—level of planning and execution, the complex set of political, military, economic, social, information, and infrastructure dimensions characterizing stability operations suggest the utility of structuring brigade and battalion operations along logical lines of operation.

Training Target/Performance Criteria

- Degree to which the area of operations has been mentally organized along either logical or physical lines of operation.
- Degree to which the lines of operation have been defined in terms of intent, mission objectives, focus, actions (lethal and non-lethal), obstacles, system effects, decisive points, and culminating points.
- Degree to which key elements of the lines of effects have been articulated in terms of commonly understood doctrinal language and mnemonic devices.

Skill Area 3 – Synchronize Vertically Across the Commander and Staff

Visualization involves an active collaboration between the commander (who defines the problem space in terms of purpose, focus, and general system effects) and the staff (who analytically develops the problem space in terms of specific influence mechanisms and pathways, operational environment objects, actions, resources, and timing). The goal of this vertical collaboration is the development and maintenance of shared understanding of the envisioned problem space between the commander and his supporting staff. This process of collaboration is orchestrated into a sequence of commonly understood planning steps and decision points that specifies when specific types of knowledge products are produced, shared, and updated. While the internal mental processes the commander and the staff develop elements of the problem space on an emergent—or asynchronous—basis, the external codification and

sharing of this actionable knowledge must follow a predictable staff rhythm in order to efficiently focus and employ these scarce cognitive resources.

The Army's MDMP outlines a specific set of planning steps that begin with the receipt of mission orders from the next higher command, move into the mission analysis, proceed through the development and analysis of a specific COA, produce a set of mission orders for subordinate commanders, and culminate with the execution of the envisioned plan. In terms of developing and updating the envisioned problem space, the commander's initial visualization of mission purpose, focus, and general system effects begins during the mission analysis phase of planning. However, refinement of this portion of the problem space continues through the COA development and analysis as the commander receives new information and staff input. Likewise, the staff's analytical identification and development of specific influence mechanisms, pathways, and operational environment objects begins during the mission analysis phase, continues in its association of actions, resources, and timing through the COA development and analysis phase as new intelligence is received, and culminates with the refinement of specific object/action/resource pairings during the targeting process that supports execution.

For these two aspects of visualization to work efficiently and in harmony with one another, the commander and staff must codify their respective knowledge contributions in a doctrinally-defined manner. Purpose, focus, and general system effects are documented in Commander's Intent and Commander's Planning Guidance. Specific influence mechanisms, pathways, and operational environment objects are identified through a system-of-systems analysis and documented in the Intelligence Preparation of the Battlefield and Running Estimate. In stability operations and urban operations, the staff's understanding of these influence mechanisms, pathways, and objects is documented in various other supplemental forms of knowledge such as the matrices, diagrams, charts, and graphic overlays shown in Figure 21. Here, the staff uses the best format for describing and highlighting the specific nature and relevance of each influence mechanism, pathway, or object of interest. To be useful as a guide for planning and execution, such products are updated throughout the MDMP cycle and maintained in a form that is easily accessible by the staff.

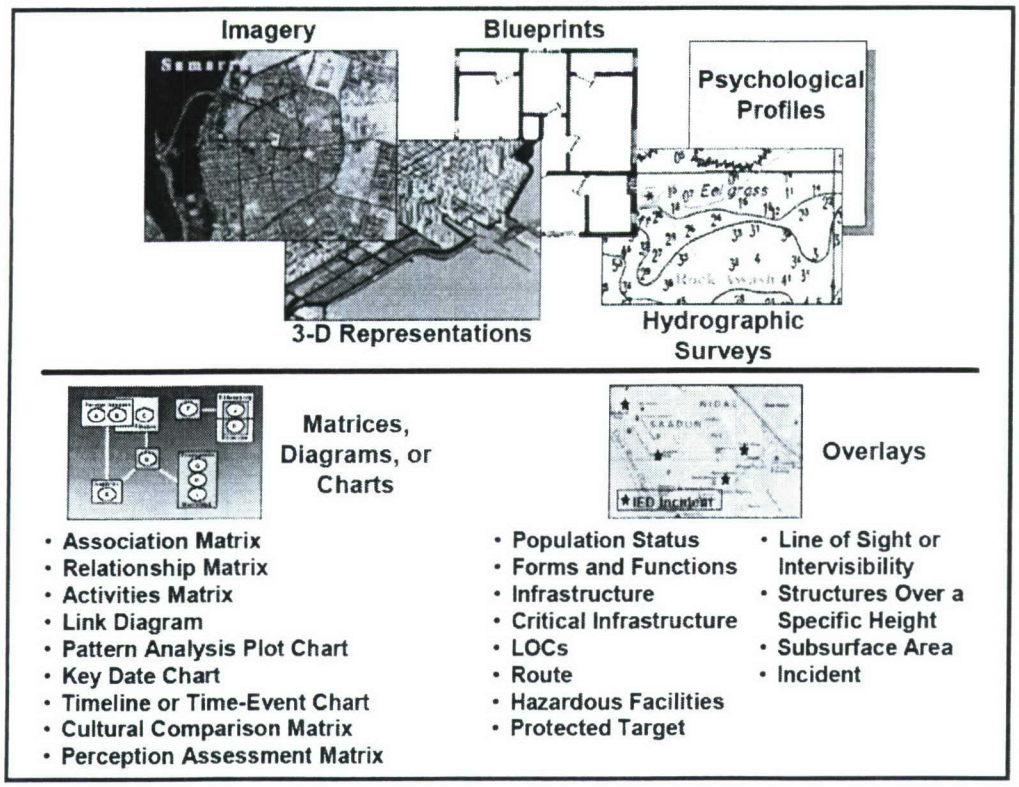

Figure 21. Codifying Visualization Knowledge in Various Forms.

Training Target/Performance Criteria

- Degree to which the specific MDMP documents (e.g., Commander's Intent, Running Estimate) identifies and articulates each of the key knowledge elements and their associational linkages defined in the envisioned problem space (product quality).
- Degree to which these knowledge products are developed and updated in a timely manner in response to the decision-making needs of the commander (product timeliness).
- Degree to which these knowledge products are maintained in a clearly understood and accessible manner (product clarity).
- Degree to which the commander and staff vertically share a common understanding of the visualization space through the documentation and exchange of these knowledge products (product impact).

Skill Area 4 – Synchronize Visualization across METT-TC and warfighting functions

It is important that the visualization space horizontally reflect each of the relevant dimensions of the operational environment. From a doctrinal point of view, this implies the need to decompose each of the METT-TC factors to an appropriate level of detail that matches the complexity of the operational environment. In the case of linear combat operations conducted to defeat an organized enemy force, focus is traditionally placed on the mission, enemy, terrain/weather, troops, and timing aspects of METT-TC. However, the advent of modern stability operations has placed increased emphasis on understanding the civilian component of the operational environment. Indeed, in many stability operations, the civilian population is

considered a center of gravity. Development of understanding in this area generally requires the decomposition of this METT-TC factor into a more detailed ontology that addresses the various types of political, military, economic, social, cultural, and religious nodes that define a population and the associated linkages that bind a population together. Here, memory devices such as the Army's ASCOPE mnemonic can serve to structure the development of the problem space. Joint acronyms such as PMESII may be used in some settings when the commander and staff must collaborate across service boundaries. Still other phrases such as "atmospherics" can arise to meet the needs of commanders in local situations. In each case, however, the ontology must be both clearly understood by all staff members and must be comprehensive in its coverage of the relevant operational environment dimensions affecting the commander's operation.

Horizontal synchronization is accomplished at the tactical level of command primarily through the establishment and definition of staff working groups and informal staff huddles convened on an ad hoc basis. Each case reflects the formation of a community of interest comprised of relevant areas of expertise or awareness that are focused on a specific problem or issue relevant to the development of the envisioned problem space. Example working groups might address broad issues such as target development, civil-military affairs, and information operations, or they might be more specifically focused on problems such as refuge resettlement or improved explosive device tactics. Working groups and staff huddles are formed at the discretion of the commander, based on his judgment that a specific aspect of the envisioned problem space requires further development. In any case, however, a working group or huddle requires appropriate definition by the commander (or a designated officer) in order to be effective and efficient. This definition includes:

- Purpose and frequency of the group's meeting (articulation of the specific problem or issue to be addressed).
- Required composition of functional expertise (including both unit staff elements, liaison representatives from other organizations, and reach-back expertise).
- Required information inputs from other working groups, headquarters, and external agencies.
- Expected knowledge elements or documents to be produced by the group (e.g., matrices, prioritized target lists, recommendations).
- Meeting agenda (order in which the group will systematically consider information inputs and deliberate knowledge products).

The knowledge creation ability of each working group or huddle depends critically upon the effective participation of appropriate functional experts. If a specific area of functional expertise is either missing or barred from effective contribution, then it is likely that this will result in a corresponding gap of understanding and—ultimately—decisions and actions that produce unintended negative consequences. To minimize this possibility, it is important for the commander (or his designated knowledge management representative) to carefully identify the types of functional expertise and informational inputs needed for each collaborative group. Secondly, it is important that the unit's standard operating procedures (SOP) serve to identify and resolve any type of collaboration barrier that might prevent the effective contribution of an individual participant. Barriers can be cognitive (lack of common language or ontology), social

(lack of trust or professional acceptance), parochial (organizational boundaries), or technical (lack of network connectivity and/or collaboration tools) in nature.

Training Target/Performance Criteria

- Degree to which the visualization space addresses each relevant dimension of the operational environment affecting the commander's operational progress and success.
- Degree to which the identified dimensions have been decomposed and articulated in terms of commonly understood doctrinal language and mnemonic devices.
- Degree to which the commander has identified areas of the visualization space requiring further analytical development (area of operationally significant ambiguity or equivocality).
- Degree to which an appropriate working group or staff huddle has been designated to address each area requiring further analytical development.
- Degree to which the designated working groups and huddles have been appropriately defined in terms of purpose, frequency, composition, inputs, outputs, and agenda.
- Degree to which collaboration barriers have been minimized or eliminated.

Skill Area 5 – Synchronize immediate operations with long-term objectives and consequences

Visualization requires the proper balancing of attention between immediate operations and long-term mission objectives. When the visualization space is organized into multiple logical lines of operation, it is likely that these lines of operation will reflect different time scales. It is also likely that some lines of operation will emphasize the use of violent, lethal actions, while other lines of operation primarily involve non-lethal means of influence. For the overall campaign to be successful, the commander must balance or synchronize these sometimes competing aspects of his operation in his construction of the envisioned problem space. For example, in stability operations, establishing security conditions for a civilian population will likely emphasize lethal actions focused against various insurgency elements. Here, the focus of the commander and staff's attention will be on the rapid and decisive engagement of insurgency elements, with the immediate effect being one of defeat or destruction. By contrast, other goals of the stability operation—such as the reconstruction of a society—might not be achievable in the short term. Success often requires perseverance, a long-term commitment to solving the real problem. The achievement of these goals may take years.

The volatile and politically charged nature of the operational environment associated with stability operations implies that individual and small unit actions can create unintended negative consequences disproportionate to the level of command or amount of forces involved. At the same time, stability operations occur in full view of the public and press. Commanders will have at their disposal more combat power than is often needed or prudent to apply in a given tactical situation, and a single act of indiscipline or rash application of this combat power can undo a civilian population's level of trust and cooperation that has taken months or years to build. From a visualization perspective, this elevates the importance of the "civilian" element of METT-TC—thus requiring the commander to consider civilians as a center of gravity, rather than merely as a shaping factor for combat operations.

A major part of achieving this balance involves understanding the potential for second-order effects and unintended negative consequences. Immediate operations—particularly those of a violent lethal nature—can potentially have a negative collateral impact on a civilian population. The second-order effects of these actions can quickly undo months or years of humanitarian or reconstruction activities designed to "win the hearts and minds of the civilian population." In turn, the creation of negative attitudes towards an occupying military force can lower the willingness of civilians to provide actionable intelligence, increase their tolerance for insurgency cells within their neighborhoods, and even increase their likelihood of actively supporting the insurgency (e.g., construct and implant IEDs).

Consequently, it is important for the staff to expand the visualization space in terms of its understanding of potential second-order effects on civilians and infrastructure and their impact on long-term mission objectives. This begins with the commander's overall guidance and continues down through the staff's analytical expansion of the visualization space. The bulk of this visualization process occurs primarily at system effects level of analysis conducted within the various working groups and boards, and requires deliberate war-gaming analysis of planned actions across each of the relevant political, military, economic, social, cultural, and religious nodes that define a population and the associated linkages that bind a population together. Here, it is important for functional experts to identify likely areas of sensitivity across the ASCOPE dimensions and to avoid "mirror-imaging"—overlaying one's own values and thought processes on the civilian population. It is also important that the results of this type of "second-order effects analysis" be highlighted within the Running Estimate and used in the COA development and targeting processes to vet proposed actions.

Exploitation of this second-order effects analysis occurs during the planning of specific tactical operations (e.g., raids, sweeps, cordon and searches) where the staff formally considers what additional types of information operations or reparation actions might be required in order to (1) thoroughly explain the necessity of a particular operation to local civilians and/or (2) compensate civilians for damage inflicted on lives or property.

Training Target/Performance Criteria

- Degree to which the commander highlights or underscores the operational and tactical significance of second-order effects and unintended consequences in his Commander's Guidance.
- Degree to which the staff identifies potential areas of second-order effects and negative consequences through systems effects analysis.
- Degree to which the results of second-order effects analyses are used to vet planned actions.
- Degree to which the results of second-order effects analysis are used to identify appropriate information operations or reparation actions required in conjunction with planned lethal actions.

Skill Area 6 – Synchronize Visualization across Relevant Player Perspectives and Interests

Visualization includes synchronization of the visualization space with other units/organizations and relevant players within the commander's AO in order to achieve unity of purpose and efficiency of operation. Tactical operations are typically carried out in a joint service context where the commander must coordinate his envisioned operation with (1) adjacent military units that are often from another service, (2) other types of military units (e.g., Special Operations teams, logistics units) operating in a transient manner within his own AO, and (3) a military unit that is conducting a Relief in Place Transfer of Authority (RIPTOA) operation. Similarly, the commander's operations might often form part of a larger interagency and multinational campaign effort. This implies the need for the commander to coordinate his operations with U.S. governmental departments and agencies; nongovernmental organizations; contractors supporting other agencies; host-nation and partner-nation organizations; regional, international, and United Nations organization; and coalition partner military units. In stability operations, the need for coordination extends to local host-nation power brokers who potentially play a relevant role in the country's development and acceptance of responsibility for security and governance. In each case, this requires the commander to synchronize his envisioned problem space across multiple player perspectives in order to maintain unity of purpose.

From a visualization perspective, these various areas of coordination imply the need for skill in two overlapping areas: (1) the sharing of understanding and (2) the negotiation of understanding. The sharing of understanding is relevant in situations where the commander must insure that another unit or organization sees the operational environment from the same perspective. This is particularly important for RIP/TOA operations where passing locally gained experience from the departing unit enables the incoming unit to immediately operate at a higher point on the learning curve. The sharing of understanding can be accomplished at several levels of detail and interaction. The passing of specific planning documents—e.g., Commander's Intent, Commander's Guidance, Intelligence Preparation of the Battlefield, Running Estimate, Target Folders, operational graphics—produces the lowest level of shared understanding. Sharing the products of the system effects analyses—e.g., the types of matrices, diagrams, charts, and graphic overlays shown in Figure 21—will provide a deeper level of shared understanding. Similarly, the sharing of target folders will add to a deeper level of shared understanding. However, much of the envisioned problem space—e.g., perceived risks, uncertainties, causal linkage strengths, operational environment object value—will be hard to express in specific documents and essentially remain as tacit knowledge held by the commander and staff. For this reason, the highest form of shared understanding is developed when the staff members from one unit engage in extensive dialog with their counterparts in the other unit. For operations during a stability operations phase of a campaign, units benefit by beginning this dialog as much as six months prior to the actual transfer.

The negotiation of understanding is relevant in situations where another unit, civilian power broker, or other key player within the commander's AO operates with a different set of goals, priorities, agenda, or perspective. In this case, the commander—or his delegated representative—must plan and engage in deliberate negotiations with the other party to deconflict and/or reconcile these differences and promote unity of purpose. The use of force during stability operations is typically a last resort—an option that remains when all else has

failed to accomplish assigned mission goals. Here, a commander must develop alternatives to the use of force, such as deterrence, control measures, compulsion by incentive or penalties, protection, warning, non-lethal measures, and negotiation.

From a visualization perspective, well-planned negotiations require the commander to have a clear understanding of his operational problem, the options and alternative paths that can logically connect intention with action within his visualization space, and the minimum essential conditions under which that visualization space remains viable. The planning of negotiations must also keep the following principles in mind:

- Resolve problems and issues at the lowest level as quickly as possible to prevent small incidents from escalating into serious confrontations.
- Identify the most appropriate delegate to represent the unit, keeping in mind the political, social, and cultural impact this will have on the likelihood of success.
- Prepare for each negotiation session by (1) understanding your own problem space, (2) understanding the views and positions of the other participants, and (3) becoming aware of any other agreements relevant to the current situation.
- Carefully arrange the time and place of the negotiations, including appropriate security and travel arrangements.
- Plan a negotiation strategy relative to the envisioned problem space, including a sequence of fall-back positions and minimum acceptable states.
- Conclude the negotiations in a clarified manner, noting all points of compromise and their impact on the commander's envisioned problem space.

Training Target/Performance Criteria

- Degree to which the commander highlights or underscores the operational and tactical significance of developing and maintaining shared understanding with other units and organizations within his AO.
- Degree to which shared understanding is achieved with other units and organizations—e.g., shared planning documents, shared products of system effects analyses, staff dialog.
- Degree to which the commander highlights or underscores the operational and tactical significance of deconflicting and/or reconciling goals, priorities, agenda, or perspectives of other key players—e.g., local civilian power brokers—within his AO.
- Degree to which the commander employs the principles of effective negotiation in dealing with each relevant player.

Skill Area 7 – Develop Meaningful Measures of Effectiveness to track progress along each line of operation

Visualization includes the effective translation of the visualization space into meaningful and correctly defined *measures of effectiveness* (MOE). Commanders develop and use MOE to support assessment of progress during execution. A measure of effectives is a criterion used to assess changes in system behavior, capability, or operational environment that is logically associated with the achievement of an objective, attainment of a desired end state, or creation of a desired effect. The MOE focuses on the results and consequences of unit actions. They assist

the commander in determining if these actions are appropriate, or are different or alternative actions required. If direct measurement is not possible, then appropriate indicators of achieving the objective, end state, or effect are measured. Given the complexity of modern military operations, commanders and staff must apply analysis and judgment in developing conclusions from a set of MOE. Careful focusing and definition of MOE is essential to avoid information overload and the wasteful use of limited staff resources. Additionally, the collection and reporting of information required to assess MOE should not overburden lower echelons of command without a staff—e.g., company and below.

Measures of effectiveness flow directly from the structure and content of the visualization space. A clear understanding of the problem space—in terms of purpose, focus, system effects, objects, actions, resources, and timing—is required to identify and define an appropriate and focused set of MOE. Additionally, MOE definition typically follows the vertical linkage of these knowledge elements along logical and physical lines of operation. The MOE associated with specific system effects will likely be more quantitative in nature, while MOE regarding abstract centers of gravity, end states, and mission objectives will require more qualitative judgment and interpretation. [Note: MOE should not be confused with measures of performance (MOP) that reflect criteria used measure task accomplishment. Hence, MOP typically addresses actions, resources, and timing.]

In order to be useful for supporting assessment, MOE should have the following characteristics:

- The MOEs must be measurable in either a quantitative of qualitative fashion. Quantitative measures are preferred, but not always possible. Where qualitative measures are used, they must be tied to clearly defined criteria that can be unambiguously understood by the staff.
- The MOEs must be discrete—i.e., linked to a distinct aspect of the commander's envisioned problem space. The number of MOEs must be limited in order to avoid over tasking the staff's ability to monitor and assess them and the commander's ability to absorb and understand their significance.
- The MOEs must be relevant to the essential parts of the commander's visualization. Development of relevant MOEs is usually difficult and depends upon the degree to which the mental models underlying the commander's focal knowledge space have been clearly defined and shared in an unambiguous manner with the staff. One caution is that aspects of the operation that are easily quantified are not always highly relevant to measuring operational progress. To be relevant, an effective MOE must be associated with specific, identified nodes and links across relevant political, military, economic, social, cultural, religious, information, and infrastructure dimensions of the operational environment.
- The MOEs must be responsive. That is, they must be capable of quickly revealing important changes in the situation. The MOE responsiveness is required in order for the commander to operate inside of the enemy's decision cycle.

Training Target/Performance Criteria

- Degree to which MOE clearly illuminate and account for key elements defining each line of operation—e.g., mission objectives, commander's intent, desired end state, center of gravity, desired effects, obstacles/threats, decisive points, and culminating points.
- Degree to which MOE are either measurable or assessable in a transparent manner (clear evaluation criteria).
- Degree to which individual MOE focus on discrete aspects of the visualization space (help to isolate area of decision choice).
- Degree to which MOE are relevant to the overall structure of the visualization space (comprehensive, with no critical tree branch left unaddressed).

Skill Area 8 – Focus Information Collection and Interpretation around the Visualization Space

Visualization involves the organization and focusing of the unit's collection and interpretation of available operational environment information in an efficient and purposeful manner. This organization and focusing process closely follows the structure and content of the envisioned problem space, and specifically highlights areas of uncertainty, ambiguity, and equivocality. Here, the identification of Commander's Critical Information Requirements (CCIR)—and, in particular, the Priority Intelligence Requirements—should define the need for additional information and assessment according to the following areas:

- Uncertainty – The lack of known types of information needed to validate or instantiate a specific mental model linking purpose, focus, system effects, objects, actions, resources, and timing. Uncertainty is typically an issue in situations where a familiar battle calculus can be applied to interpret the situation. A major focus here is the cost/time of information collection and analysis versus the window of decision opportunity provided the commander.
- Equivocality – The need for additional functional expertise and/or information in order to resolve multiple interpretations of a purpose, focus, system effect, object, action, resource, or timing issue. Equivocality is typically an issue in situations involving multiple relevant dimensions of the operational environment, the potential for second-order unintended consequences, and/or conflicting player perspectives. A major focus here is the cost/time of integrating additional areas of functional expertise and/or information into the unit's planning process versus (1) the window of decision opportunity provided the commander and (2) the cost of ineffective operations or unintended negative consequences.
- Ambiguity – The need for additional functional expertise combined with the use of pattern/trends analysis to identify relevant operational variances and/or discover additional system effects that can be subsequently exploited for operational advantage. A major focus here is the need to (1) maintain mission progress and (2) develop greater understanding of the operational environment.

It is important for the commander and staff to develop a shared understanding of the envisioned problem space—i.e., key problem elements and lines of operation—so that the information, assessments, and recommendations generated in response to these *CCIR* are

contextually linked with operational objectives and strategies. This will insure that available staff resources are used in an efficient manner and that the commander's needs are effectively satisfied.

The CCIR—and the resulting Intelligence, Surveillance, and Reconnaissance (ISR) Plan that flows from it—must be continuously updated as the commander's envisioned problem space evolves over time. Thus, it is useful for the unit—usually through the designation of a knowledge manager (e.g., XO or S-2)—to closely track changes in envisioned purpose, focus, system effects, objects, actions, resources, and timing and to insure that the CCIR and ISR Plan remain consistent with the envisioned problem space.

Training Target/Performance Criteria

- Degree to which operationally significant areas of uncertainty, equivocality, and ambiguity are distinctly identified and articulated in terms of CCIR.
- Degree to which information, assessments, and recommendations generated in response to CCIR are contextually linked with operational objectives and strategies.
- Degree to which the CCIR and ISR Plan are updated in response to changes in mission objectives, commander's intent, and operational plan.

Skill Area 9 – Identify Patterns/Trends and Maintain Unity of Purpose

Visualization includes the tracking of key problem elements and lines of operation over time to identify meaning patterns or trends and to maintain unity of purpose with respect to long-term mission objectives. This involves the development of a Running Estimate, the staff's continuous assessment of current and future operations to determine if (1) the current operation is proceeding according to the Commander's Intent and (2) future operations are supportable. The Running Estimate is framed by the key problem elements and lines of operation defined within the commander's envisioned problem space, and is structured to highlight known facts and validated mental models, risks (operational significant areas of uncertainty, equivocality, ambiguity), critical assumptions, current patterns and trends of activity or change, and associated interpretations and recommendations. It addresses (1) the vertical spectrum of knowledge elements that define purpose, focus, system effects, objects, actions, resources, and timing; (2) the horizontal spectrum of METT-TC dimensions and warfighting functions; (3) unity of purpose across immediate operations and long-term mission objectives; and (4) the range of relevant player interests within the commander's AO. Running Estimates help the commander to identify and frame critical decision opportunities. Running Estimates are continuously maintained and updated throughout the planning and execution rhythm in response to the progress of operations and the evolution of the operational environment.

Variances identify and define an operational significant difference between a forecasted event or state within the commander's AO and the actual situation. In turn, forecasted events and states are developed from a projection (into the future) of the mental models underlying the envisioned problem space. While these mental models generally remain as part of the commander and staff's tacit knowledge, their corresponding vertical and horizontal linkage of key problem elements provides a framework for organizing and assessing variances in a clear

and meaningful manner. The translation of identified variances into adjustment decisions involves the application of experience (tacit knowledge), reasoning (logical analysis of the envisioned problem space), and judgment (balancing risk and opportunity). By maintaining a good understanding of the vertical and horizontal linkages within the envisioned problem space, the commander is able to systematically apply experience, reasoning, and judgment in order to identify and initiate adjustment decisions at the lowest possible level of detail. For example, the commander might begin by adjusting actions and resources to accomplish the same desired system effect. If this is not feasible, then system effects will be adjusted to influence a center of gravity in a different manner. If this does not achieve the desired rate of progress, then the commander might redefine a center of gravity or replace it with another one in order to achieve a desired end state. Only as a last resort would the commander consider a redefinition of end states and objectives since this directly impacts on the ability of his parent command to accomplish its broader mission objectives.

Variances correspond to either emerging opportunities or emerging threats. The first type of variance reflects an opportunity to accomplish the mission more effectively. Opportunities result from forecasted or unexpected successes. When they recognize an opportunity, commanders alter the order to exploit it if the change achieves the end state without incurring unacceptable risk. Exploiting a forecasted opportunity usually involves executing a branch or sequel. When exploiting an opportunity, the concept of operations may change, but the commander's intent usually remains the same. The second type of variance reflects a threat to mission accomplishment or survival of the force. When a threat is recognized, the commander adjusts the order to eliminate the enemy advantage, restore the friendly advantage, and regain the initiative. Not all threats to the force or mission involve hostile or neutral persons. Disease, toxic hazards, and natural disasters are examples of other threats that may arise. In recognizing opportunities and threats, it is imperative that the commander and staff maintain balanced attention across each defined line of operation. Particularly in stability operations, there is a tendency for lethal operations to channel the attention of the commander and staff away from other logical lines of operation (e.g., economic reconstruction, governance, host nation security forces). The proper structuring and tracking of variances across the envisioned problem space will help to maximize the overall effectiveness of the unit.

The effective identification and tracking of variances depends upon the careful focusing and definition of MOE (Skill Area 7) and the efficient and purposeful collection and interpretation of operational environment information (Skill Area 8). Consequently, the ability of the commander and staff to identify operationally significant variances and translate them into timely adjustment decisions will be no greater than their performance in these other visualization skill areas.

Training Target/Performance Criteria

- Degree to which the Running Estimate identifies operationally significant patterns, trends, and changes across the vertical spectrum of knowledge elements that define and link purpose, focus, system effects, objects, actions (lethal and non-lethal), resources, and timing of the operation.

- Degree to which the Running Estimate identifies operationally significant patterns, trends, and changes across the horizontal spectrum of METT-TC dimensions of the operational environment.
- Degree to which the Running Estimate addresses unity of purpose across immediate operations and long-term mission objectives.
- Degree to which the Running Estimate identifies operationally significant patterns, trends, and changes across the range of relevant player interests within the commander's AO.
- Degree to which variances are structured and tracked in a balanced manner across each of the lines of operation.

Skill Area 10 – Focus Targeting of Shaping and Probing Actions

Visualization includes the commander's use of his visualization space to efficiently focus shaping actions and probing actions. Much of the visualization process involves the passive interpretation of available information within a contextual framework of experience and expertise. However, this process also involves the proactive use of shaping actions to reduce areas of risk and uncertainty and/or probing actions to discover system effect opportunities that can be subsequently exploited. Thus, visualization reflects both an attempt to conform mental understanding to reality, and influence reality toward the mental vision of the commander. Shaping actions and probing actions are particularly relevant in stability operations where the commander must simultaneously seek to stabilize an operational situation, reduce the complexity of the many interacting dimensions of the operational environment, and gain greater understanding of potential leverage points.

Shaping actions are often considered at the beginning of a campaign or major operation to set the conditions for success. Hence, they should be formally addressed as part of long-range planning where key elements of the envisioned problem space are projected into the future. Commanders describe an operation in terms suited to their experience and nature of the mission. They use an operational framework such as METT-TC and the elements of operational design to describe the relationship of decisive, shaping, and sustaining operations to time and space. When synchronizing operations along logical lines of operation, a commander should specify which logical line of operation is the decisive operation and which are shaping operations. Because shaping actions consume combat resources that would otherwise be employed for decisive operations, they must be carefully identified and focused according to the commander's overall understanding of the operational environment. Areas of identified risk and uncertainty provide a framework for identifying where shaping actions are needed and what these shaping actions ought to look like. These areas of risk and uncertainty are identified from a systematic analysis and prioritization of the key problem elements within the envisioned problem space.

Execution requires the commander to build and maintain momentum by continuously assessing and synchronizing operations, and by constantly pressuring the adversary. Effective commanders control operational tempo to present the adversaries with new problems before they can solve current ones. In terms of stability operations, effective commanders maintain momentum by seeking new pathways of influence and leverage points across the different political, military, economic, social, cultural, and religious nodes that define a population and the

associated linkages that bind a population together. Often, these different aspects of a campaign will be conducted simultaneously in what some have termed "the three-block war." An essential component of building and maintaining momentum in a complex and simultaneous operational environment is the use of probing actions. Probing actions—if they are supported with appropriate collection and interpretation of information gained as part of these operations—allow the commander to discover or reveal functional relationships within the operational environment that sustain an adversary, influence a civilian population or host nation, or affect some other relevant METT-TC factor. Like shaping actions, probing actions consume combat resources that would otherwise be employed for decisive operations. Consequently, they must be carefully identified and focused according to the commander's overall understanding of the operational environment. Areas of identified equivocality and ambiguity provide a framework for identifying where probing actions are needed and what these probing actions ought to look like. As in the case of shaping actions, these areas of equivocality and ambiguity are identified from a systematic analysis and prioritization of the key problem elements within the envisioned problem space.

Training Target/Performance Criteria

- Degree to which operationally significant areas of risk and uncertainty are translated into effective shaping actions (typically identified at the beginning of an operational campaign).
- Degree to which shaping actions are appropriately prioritized and resourced in relation to decisive operations (accomplished through systematic analysis of key problem elements)
- Degree to which operationally significant areas of equivocality and ambiguity are translated into effective probing actions (identified throughout execution to maintain momentum).
- Degree to which probing actions are appropriately prioritized and resourced in relation to decisive operations (accomplished through systematic analysis of key problem elements and areas of ambiguity/equivocality).

Skill Area 11 – Discover and Exploit Newly Revealed Pathways of Influence

Visualization involves positioning and focusing the unit's battle rhythm to enable rapid discovery and exploitation of newly revealed functional relationships within the operational environment that sustain an adversary, influence a civilian population or host nation, or affect some other relevant METT-TC factor. Each of these functional relationships reflects potential pathways of influence for achieving mission goals. Opportunities for discovering these relationships might come about through deliberate planning of probing actions (Skill Area 10) or be serendipitous in nature. In either case, the maintenance of operational momentum will depend upon the unit's ability to translate this actionable knowledge into action. In traditional linear combat operations, exploitation typically follows a decisive phase of operation. However, in stability operations, exploitation occurs in a more continuous manner as the commander seeks to build his understanding of the operational environment.

In stability operations, discovery and exploitation will depend to a large degree upon actionable intelligence developed by the unit from its own execution of operations. Sources of actionable intelligence might come from any of the unit's organic reconnaissance, intelligence,

surveillance, and target acquisition (RISTA) systems; however, the bulk of this intelligence will likely come through HUMINT exploitation. The HUMINT will involve the exploitation of key documents discovered during raids and searches, contacts with local civilians during presence patrols, intelligence shared by other units and organizations (e.g., Special Forces), and information gained during negotiations with key players (e.g., local power brokers) within the commander's AO. Accordingly, the commander must develop a plan for systematically identifying, collecting, interpreting, and exploiting such information vis-à-vis his envisioned problem space. This will include development of a traditional ISR Plan (e.g., use of SIGINT, unmanned aircraft system (UAS), national assets) by the S-2 staff section, but will also extend to emphasize other information collection strategies such as:

- Requirement for translators that facilitate interactions with civilians and document exploitation.
- Use of every Soldier within the unit as a potential HUMINT collector (including effective debriefings and after-action reviews).
- Use of different operations (e.g., traffic control points, presence patrols) as information collection opportunities.
- Identification and prioritization of information needs prior to individual combat operations.
- Identification and prioritization of information needs prior to planned negotiation sessions.
- Recruiting, vetting, and maintenance of informant networks (including strategies that minimize the vulnerability of informants to insurgency forces).
- Monitoring local media and other information outlets (e.g., mosques).
- Gathering available documentation relevant to the description of urban societies, social and cultural networks, organizations, infrastructure, etc.

Urban environments provide a wealth of information collection opportunities that can overwhelm the limited analytical resources of a staff. Consequently, the collection, interpretation, and exploitation of available information must be undertaken in a systematic and focused manner, using the commander's envisioned problem space as a framework for these activities. As new functional relationships and potential influence pathways are discovered, they are incorporated into the various forms of knowledge such as the matrices, diagrams, charts, and graphic overlays shown in Figure 21. These various forms of codified knowledge then become the basis for identifying actions and developing FRAGO that can capitalize on these new discoveries in a timely manner. Organizing the discovery and exploitation process according to the key problem elements and lines of operation will help to insure that available staff resources are used in an efficient manner and that the commander's operational priorities are effectively satisfied.

Training Target/Performance Criteria

- Degree to which the commander employs a full range of information collection strategies to enable discovery of functional relationships and influence pathways within the operational environment.

- Degree to which the process of discovery is focused by key problem elements and lines of operation expressed within the commander's envisioned problem space.
- Degree to which discoveries are systematically incorporated into the various forms of knowledge (e.g., matrices, diagrams, charts, and graphic overlays) maintained within the unit.
- Degree to which the commander acts on the information gathered in a timely manner.

Transforming Cognitive Task Analysis Results into Instruction

One purpose of the cognitive task analysis is to serve as the basis for training. Conducting a cognitive task analysis is required before creating instruction—you must understand expert behaviors and performance before developing instruction to train novices to perform like experts. However, the results of a cognitive task analysis must still be transformed into products that can be used to train. For example, it might be that an expert Soldier builds view of the operational environment based on triggered cues, but how to train trainees that skill is unspecified. The following section of the report addresses the steps taken to transform the cognitive task analysis into training and instruction. Additionally, the proof-of-principle training that was developed and provided to a sample of officers in a formative evaluation will be discussed.

Factors Affecting Instructional Design

One of the first requirements of instructional development from a cognitive task analysis is to decompose the complex, fluid performance of the expert into smaller chunks of performance (e.g., behaviors) that become the focus of instruction. For example, in the description of experts' visualization process, the cognitive task analysis revealed that experts perform many of the skills simultaneously. However, teaching all of the skills to the trainee at once would be too much for the student. In general, an instructional goal is to deliver the optimal size learning chunk to a student. It is best if chunks are large enough to allow the trainee to work through the problem completely and easily understand the relationship between the learning chunks and the complete (whole) task. It must be accomplished while not giving the trainee chunks so large that he becomes overwhelmed.

Given that cognitive task analysis revealed 11 discrete skills areas, dividing the learning chunks into the same 11 skills was a simple, obvious approach to try. Additionally, it was clear that each skill had sub-skills that could be identified and taught to assist the trainee in becoming more competent at a particular skill. One of the important decisions that needed to be made was how the visualization process defined for each skill should be further chunked and presented to trainees.

A second requirement in instructional development from a cognitive task analysis is to characterize the nature of the task that experts perform and to specify the behavioral training objectives. Different kinds of skills often require different kinds of training. For example, for some perceptual tasks, the training might present very little theoretical background, but create lots of practice exercises where accuracy and speed of performance are essential (Fadede, 2006).

As tasks become more cognitive in nature, the instruction requires more complex cognitive challenges (Cooke, 1994).

The results of the cognitive task analysis made it clear that visualization by battalion commanders and their staff is a very complex cognitive task. Further, the expert performance of visualization often involves very complex data with automatic processing that leads to quick analysis and decisions. We stress the complexity of the visualization process revealed by the cognitive task analysis, because the reader may confuse the lay person's usual meaning of visualization versus the specialized process in military operations. A dictionary definition of visualization says "to form a mental image." So in common usage, you might be asked to visualize "a tiger attacking a herd of zebra." In a military context, visualization is much more complex: it involves an image of the operational environment, with the elements and their relationships in the present, and how they might interact to change over time. As such, the visualization process that is taught needs to help commanders learn and integrate higher order cognitive skills. The exercises developed required the students to review a complex set of data, consider complex processes, and make decisions in complex situations.

Another element of the visualization process is that visualization relies on mental models. Mental models are internal models of real world phenomena and processes. The ability to effectively visualize a dynamic battlefield relies on expert mental models. While novices and experts may use many of the same strategies and processes, experts rely on data from more exacting and elaborate mental models of situations, and make better sense out of situations (Sieck, et al., 2004). Visualization may also improve mental models. In studies of mental animation, students who were asked how the equipment worked developed the capability to visualize the equipment better than students who were presented with accurate visualizations (Hegarty, Kriz, & Cate, 2003). Hence, the mental processing required to visualize a system, strengthens the ability to create useful models of the system.

The cognitive task analysis discussed in this report focused on the visualization process, rather than specifying the underlying and necessary mental models underlying expert visualization performance. Thus, the cognitive task analysis revealed the processes to be taught (and trained), but not all of the mental models that lead to comprehensive visualization training. Although the intent of the project was to prepare commanders for present and future operations, it is impossible to specify the mental models for all future commanders. Rather than focusing on the mental models, the instruction focused on the underlying process that would use and strengthen the commander's mental model.

Limited training time restricts the amount of instruction that can be presented up front to the trainee. Therefore, the training focused on concepts that trainees were already familiar with, rather than instructing all new concepts that had similarities to existing concepts. The danger of this approach is that relying on more traditional concepts could mean that the more contemporary concepts from the cognitive task analysis might not be realized to the fullest. Given the limited training time, a goal of the proof of principle training was that it would not require significant time to complete each individual exercise. That decision limits the training of mental models, and forces the training to focus on cognitive processes. Thus, the trainees would have to rely on

their existing mental models, and elaborate and refine them with the situations that they would encounter in the training.

The reliance on traditional versus new concepts was influenced by their relationship with doctrine. The options were to (a) follow doctrine, as that is certified, known, but not always well understood; or (b) follow the outcome of the cognitive task analysis, using the new and non-doctrinal terms and concepts. We elected to follow the cognitive task analysis but modified parts of the concept that we believed were already covered under existing Army doctrine. We elected to follow the existing doctrine to prevent the confusion of the trainee and because the existing doctrine already addresses some aspects of the new concepts. Where appropriate, we added new concepts from the cognitive task analysis and related them to more traditional concepts. In the end, the training largely was based on established doctrinal concepts and terms. However, there was always tension between using existing doctrine versus implementing the findings from the cognitive task analysis that often go beyond doctrine. Our instructional decisions showed a preference for staying within doctrine while introducing new concepts.

Given the findings and limitations described above, the goal was to develop an instructional approach to training that would help trainees visualize the operational environment. For training complex cognitive decision-making skills in somewhat ambiguous but related situations, we used a set of related instructional theories and approaches based on a common theoretical viewpoint. One of these instructional approaches was deliberate practice (Ericsson, Krampe, & Tesch-Roemer, 1993; Ericsson, 1996; Lussier, Shadrick, & Prevou, 2003). Students were first provided the visualization principles representing expert behaviors, and then given multiple practice opportunities to apply the complex visualization behaviors. The practice sessions initially involve short and focused drills, with clear, focused feedback, followed by more practice opportunities to improve their deficiencies. The activities followed in deliberate practice are not far different from many other instructional approaches that aim to teach complex cognitive skills (e.g., Lussier, Shadrick, & Prevou, 2003). According to Alan Lesgold (2001), a coached practice environment parallels many of the principles, including placing trainees in situations where they must perform a reasonably complex task, where they receive instruction on principles as needed, where they compare their performance to expert performance, where they deal with more complicated situations as they develop expertise.

Perhaps the biggest difference between how Lesgold described coached practice environments and deliberate practice is that trainees in a coached, practice environment do not receive didactic instruction before they start to solve a problem. Coached practice environments were developed for a situation in which trainees had already received nine months of didactic instruction and had months of on-the-job training, so all trainees had been taught (or at least told) the principles that they should apply to the practice problems. From a relevant instructional viewpoint, the trainees in these coached practice environments, while not receiving didactic information immediately before a problem or a series of problems, are not allowed to flounder excessively in this instruction approach, and are given the instruction that will allow them to complete the assigned problem during problem solution. Coached practice environment is an approach that falls under the broad category of an instructional approaches referred to as cognitive apprenticeship.

Cognitive apprenticeship typically involves a discussion of principles, a demonstration of principle application, an opportunity to practice principles with support, followed by the need to practice applying the principles with less and less support. Just as Lesgold's coached practice environment is similar but slightly different than deliberate practice, the classical applications of cognitive apprenticeship usually refers to instructional situations that have different nuances and different applications than the 'practice' instructional approaches. Cognitive apprenticeship is frequently invoked when trainees do not need to develop the application of their knowledge to the point of automated response.

One last theoretical input to the instructional approach comes from the work on visualizing scientific processes. For example, Naryanan and Hegarty (2000) taught trainees to visualize mechanical processes with various methods, and then tested them on their ability to predict what would happen given a particular situation. The fundamental outcome is that trainees needed to do the cognitive task of working through examples themselves. Counter-intuitively, trainees learned how the equipment worked when they were not shown animations, but instead were given drills and practice in developing their own 'internal, mental animation.'

These approaches all share a fundamental view of how people learn. An important distinction between the instruction approaches result from the kinds and experiences that trainees bring to the learning environment, the domains that need to be taught, and the desired performance of the students at the end of training. Thus, we developed an instructional approach that was informed by all of the approaches discussed above. The instructional approach used these components:

- Trainees are provided the principles they need to apply; they are not left to discover the principles on their own. They either are provided the principles before the training sessions, or can easily access the principles during the training session.
- Trainees apply the principles to real-life situations. Initially, the practice sessions are focused on isolated skills that are challenging but not overwhelming.
- Trainees receive feedback, often by comparing the solutions they develop with more expert solutions. For more complex cognitive tasks, the solution review includes both the answer that the trainee developed and the path that the trainee took to reach to the answer.
- After trainees solve a problem, the next problem is designed to further progress skill development.

Given that instructional approach, and the other training factors described above, the instructional design and development focused on three issues:

- Generate a process model to provide the instruction a process to apply.
- Generate a scenario to practice applying the process model.
- Generate the guidance, control, and feedback for the demonstration, rehearsal, and execution phases of the instruction.

Process Model Generation

The cognitive task analysis provided a description of the processes that experts use to visualize operations. Given that, how do we instruct trainees, so that with practice, they will learn to perform like experts? To know what to teach the trainees, we needed a process model of visualization: we needed a coherent, easily followed set of directions that trainees can follow, apply in practice, and thus improve performance.

Developing this process model from the cognitive task analysis output was not obvious, and required many revisions, with critical review. The development of the process model began with the observation that Soldiers and recent veterans found the visualization process described by the cognitive task analysis as confusing, too complex, too abstract, and used terms and concepts that were not in doctrine. To be useful with relatively little training, it needed to be simplified, made more concrete, and use terms that would be understood; still, it had to convey the essence of the cognitive task analysis.

One feature of the cognitive task analysis description that made it so complex was that it used terms not found in doctrine, though the concepts were similar or extensions to doctrinal concepts. As described in the results of the cognitive task analysis, the visualization process includes the elements of Purpose, Focus, System Effects, Objects, Actions, Resources, and Timing. Using words outside doctrine could lead to two dangers. First, this instruction might not be supported by organizations that instruct according to doctrine. The second danger of using non-doctrinal terms is that we would have to carefully teach how each of the terms from the cognitive task analysis model are related, but different than, associated doctrinal terms. For example, when discussing "purpose" from the cognitive task analysis description of visualization, we would have to make clear how this was different from common doctrinal terms, such as mission. Further, we would need to make it clear to trainers and trainees that by learning the nuances of the new terms, they could perform better than they would by applying the doctrinal terms and concepts alone. This difficulty is exacerbated when training time is limited (which it always is).

To develop the training, we used an iterative process. First, we created a description (in military terms) of the process model involved in a skill that was a simpler description than the original cognitive task analysis output description. That was reviewed and revised by additional experts. The revised version was then reviewed by Soldiers for utility and understandability, and once again revised based on their feedback. Through iteration, we developed the process model which was used in the training to guide the learner to acquire the visualization process. Military subject matter experts (SME) who understood the output of the cognitive task analysis believed that the final process model description met the requirements of (a) being sufficiently straightforward to be understood by Soldiers, and (b) conveying the essence of the process described by the original cognitive task analysis description.

To illustrate the transformation of the skill description from the cognitive task analysis to an explicit process model, we show an original skill description, with comments (italicized) about its features that had to be transformed to become the process model used in instruction.

Skill Area 1 – Identify Key Problem Elements of the Commander's Visualization Space

The MDMP is framed and guided by the commander's visualization space. Structurally, the visualization space reflects the logical association of intent with action.

Visualization relates intent to action. At an abstract level of description, the visualization space begins with a delineation of the unit's assigned mission objectives that characterize the purpose of the operation. In turn, each mission objective is articulated in terms of a set of desired end states that translate purpose into desired accomplishment.

This is similar to relating intent (or mission objectives or purpose) into end states. From the commander's understanding of the operational environment, he will identify one or more centers of gravity that logically focus attention on specific aspects of the adversary, civilian population, or other feature of the operational environment thought to represent a key point of influence. Joint doctrine defines center of gravity as the set of characteristics, capabilities, and sources of power from which a system derives its moral or physical strength, freedom of action, and will to act. The commander's broad vision of the operation is complemented by the analytical work of the staff.

Identifying Explosive Ordnance Disposal (EOD)/Center of Gravity is important. A major challenge for the staff is the decomposition of abstract centers of gravity into specific operational environment nodes and links that provide concrete definition to the intended points of influence. In general, this system-of-systems analysis must analytically consider each of the METT-TC and ASCOPE factors in order to identify specific influence mechanisms and pathways, and to associate these pathways and mechanisms with specific operational environment nodes (objects, events, etc.) and specific types of lethal and non-lethal effects.

Visualization includes understanding influence mechanisms (intent to action) by analyzing METTC, ASCOPE, specific operational environment nodes and effects: we expect that METT-TC analysis will mention operational environment objects. For stability operations, key nodes and links can extend across a variety of political, military, economic, social, information, and infrastructure dimensions of the operational environment—thus requiring a wide range of functional expertise. Finally, the staff completes the structure of the visualization space by identifying the specific actions, required resources, and timing of application necessary to achieve the specific effects against each operational environment node.

Visualization includes considering actions, resources (troops) and timing. The upper (more abstract) level of the visualization space is initially developed as an internal mental structure (defined as focal knowledge) through the application of personal experience and training (tacit knowledge), operational principles (historical lessons learned), and doctrinal considerations (codified guidance). This internal mental process involves the triggering and validation of situation-appropriate mental models (frames) that provide a framework for interpreting available information and data. The triggering of specific mental models depends largely upon the ability of the commander and staff to detect and recognize the significance of specific cues from the operational environment. Additionally, mental models are validated

through the instantiation of critical feature slots with data/information gathered from the unit's information environment.

Cues trigger mental models. Mental models are validated by data from the world that fits the model. For this knowledge to be useful as guidance, key elements of the visualization space must be externally documented and shared in the form of Commander's Intent and Commander's Planning Guidance. Much of the staff's complementary visualization is more concrete in nature, is more highly driven by a precise calculus or rule set, and relies upon the effective integration of relevant functional expertise. Hence, it is developed through collaborative analysis and documented in the form of the IPB and the Running Estimate.

These tools assist staff in preparing content of visualization. Both contributions to the visualization—the commander's articulation of purpose and focus and the staff's articulation of systems effects, objects, actions, resources, and timing—are necessary to form a complete logical association of intent with action.

Training Target/Performance Criteria

Degree to which the commander and staff detect and interpret relevant triggering cues from the unit's information environment

Cues are detected and interpreted against mental models. Degree to which the elements of the visualization space are appropriately identified (purpose, focus, system effects, objects, actions, resources, timing) across the relevant dimensions of the operational environment.

Analysis was processed according to METT-TC and Explosive Ordnance Disposal (EOD). Degree to which the elements of the visualization space are identified using commonly understood doctrinal language and mnemonic devices.

Visualization elements are identified and understood against common doctrine and mnemonics. Degree to which the commander and staff validate the mental models underlying the visualization space definition through the instantiation of their critical feature slots.

Visualization is built of mental models that are validated by incoming data. The following three points seem to capture the high points of the expert process. If an individual does this well, their process would be similar to the process described in the full description.

- Commander should try to associate intent with action.
- The analysis of the operational environment for visualization can use common doctrinal terms and analytic units from METT-TC and EOD.
- Triggering cues are used to invoke mental models; these mental models are triggered and validated against data.

These principles are turned into the following steps of a process model:

- The commander identifies problem elements defined as: elements of METT-TC and their relationships when completing the MDMP process, how these relationships are effected by or affect the EOD, and how they impact the unit's mission and higher's intent.
- The commander builds his visualization of the battlefield by linking triggering cues to thoughts about METT-TC.
- When he thinks about each doctrine element, he visualizes each element in terms of his intent or mission, and how he can control or manipulate the element with various courses of action.
- In addition to thinking about each doctrine element individually, he thinks about the relationships between them, in terms of possible actions.
- He constructs and selects among COAs based on linking triggering cues to doctrine elements, considering how best the intent can be translated into action, based on the visualization of all the doctrinal elements and their relationships together.

Two points about this process:

- While this uses the principles of METT-TC, this process is much more than simply conducting a METT-TC analysis. The METT-TC dimensions are analyzed to convert intent to action, based on elements that are in the operational environment. The elements have been identified by triggering cues and associated mental models.
- It was not just simplified from the original skill description; it was simplified, and then reviewed for (a) congruence with the intent of the original skill description, and (b) the required straightforwardness for Soldiers' ability to apply the process.

This process was sufficiently laborious so that it was completed only for the skills that were included in the proof-of-principle training that would be delivered to trainees. Having completed this task, we expect that we could create explanations for the other skills more quickly.

Scenario Generation

After developing this process model, the instructional training approach requires that trainees learn to apply the model within a situation, or scenario. Hence we needed to create a scenario in which the process model can be applied. An appropriate scenario must meet many constraints.

- It should exercise the skills to be trained.
- It should be realistic. Otherwise, it won't be motivating (or may in fact be demotivating), and it may be difficult to transfer skills learned in an unrealistic situation to a realistic situation. The realism involves both a realistic scenario of what happens in the world and a realistic manner for the trainee, in his role as a Soldier, to engage with the realistic situation.
- It should not require excessive background knowledge. As training is always time constrained, we should minimize time spent learning about the background scenario, and maximize time spent realistically applying the principles in scenarios. There are various strategies to minimize background knowledge across scenarios:

- Keep a storyline and background knowledge constant across scenarios.
- Create a realistic but simplified set of situations.
- Rely on a known, existing situation.

Scenarios were constructed that fit these requirements by following several steps. First, the development of the scenarios for the training package was a combination of input government, military, and support personnel. First, we had to decide the operational environment in which the scenario would take place. There was a discussion about using an Iraq scenario versus a fictitious location. The final decision was a fictitious location with many of the similarities of Iraq. The main reason for this decision was the unavailability of a database and mapping program for Iraq. The decision was to use "ACME Mapper" which is widely available. The program is used by the U.S. Army Armor Center and School at Fort Knox, Kentucky, for instruction in the Armor Captains Career Course. The Road to War (RTW) used in the training was a version of one from a unit that had deployed to Iraq and it was modified to fit Iraq.

Another decision was not to give a complete operations order up front. It was determined the time needed to learn a complete operations order would take too long for the time available for the training. It was decided for brevity to give a friendly and enemy force update, task organization, brigade and division mission statements and the rules of engagement. The information provided gives enough background information for the trainee to start to form his visualization of the AO while not significantly increase time requirements.

The first vignette included a RIP/TOA brief which included briefings from the battalion staff members which provided updates on the AO. The briefs given were detailed and included many of the cues needed for the trainee to visualize the situations provided in the vignettes. The information provided in the first vignette carries through to the other vignettes and is the foundation upon which new information is considered.

The vignette situations were derived from incidents described in the interviews during the cognitive task analysis. The SMEs made a list of all the cues that were provided in the RTW, friendly and enemy update, and the RIP/TOA briefs. The visualization skill was discussed and a vignette was developed to best represent the skill being taught. A basic outline of the vignette was developed based on the cues that would be used from the list. The vignette was then scripted and the appropriate map, overlays, and visual cues were added to the vignette. Upon completion of framing the vignette, considerations, and solution were prepared by the SMEs on how an expert might visualize the situation presented in the vignette. In the crawl vignettes the cues were highlighted in the answer to help show the relationships between the cues and the visualization process

After the draft of a vignette was completed it was sent to in-house personnel and to military personnel outside for feedback. The review process went back and forth several times before the final product was completed. During the iterative process numerous communications were made with active military experts to discuss recommendations and to decide on the final revision. Minor revisions were made based on the evaluation/feedback of the trainees at Fort Hood, TX. The final revisions were made after a second evaluation with leaders at Fort Leavenworth, KS.

Demonstration, Rehearsal, and Execution Generation

Trainees, using the instructional approach previously outlined, will need to see the model demonstrated, and then apply it themselves. The critical question resulting from this requirement is to decide the amount of effort spent on presenting the process model, and in what ways the trainee should practice applying the model. A common Army training approach is to provide up-front didactic instruction (tell the trainees what the principle is). Another common instructional approach of "crawl, walk, run" where crawl involves demonstrating to the trainee the principle within a situation, walk involves the trainee rehearsing parts of the process model, and then run involves executing the complete process. Those common approaches were applied to develop the training.

For the demonstration phase (crawl), we developed two ways to demonstrate application of one or more visualization skills. One method was to present the expert's thought process via text on PowerPoint slides that the trainees could read to understand an expert commander's thought process. An alternative method of demonstrating the commander's thought process was to present the commander's deliberations auditorally, while visually presenting short phrases of what the commander said, while linking related thoughts (phrases) together with labeled arrows. The intent was to demonstrate and present pictorially the relationship between commander's thoughts and thought process model, as shown in Figure 22.

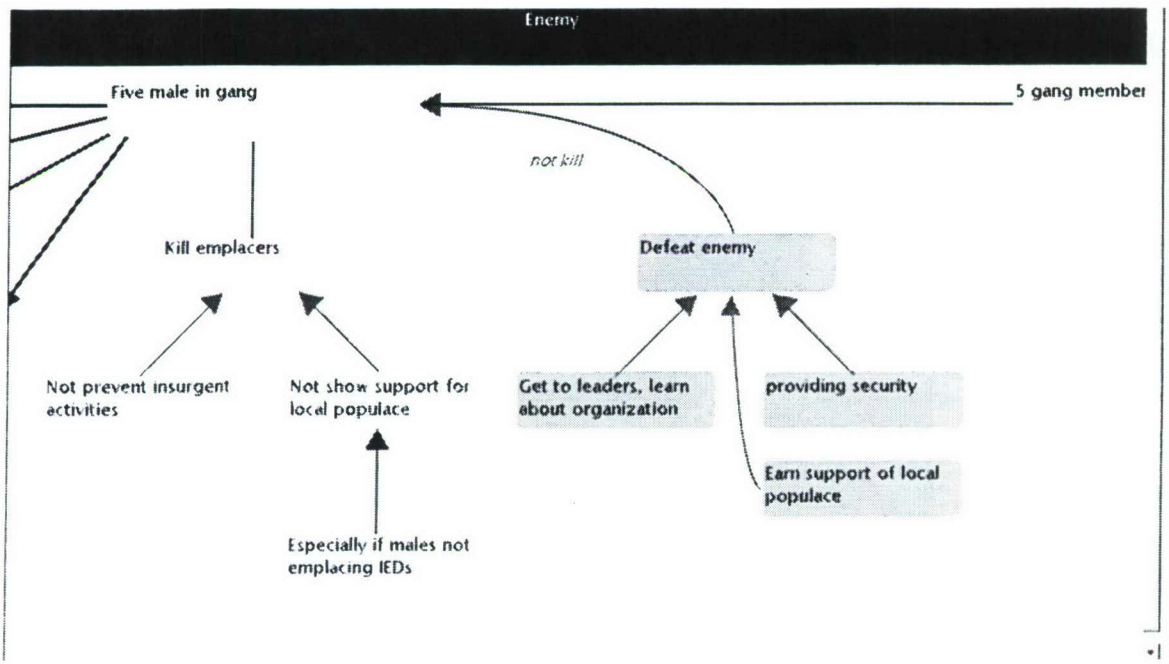

Figure 22. Example diagram showing snapshot of dynamic mind map.

For the rehearsal drills (walk), trainees were asked to conduct part of the visualization process that had just been demonstrated (in the crawl phase) to a new scenario. The scenario background for the new situation was presented, and the trainee answered questions that led the trainee through the visualization process, as described by the process model. The questions required trainees to consider the relationships between each dimension of METT-TC against the

available cues, and see how each of these dimensions guides the commander in developing intent to action. The questions presented to the trainee were intended to lead the trainee through this process by scaffolding the learning process. Expert solutions were also developed that could be presented to trainees for each of the questions. Trainees had to self-assess their answers against the expert solution.

For the full task training (run), trainees were asked to complete the entire visualization process for a scenario. They had to record the results of their visualization process, and assess it against an expert's answer.

The training was created using the instruction principles described above. Please see (McElroy, et al., In Preparation) to review the proof-of-principle training packages. Table 1 can be used as a reference to link the principles and rationales expressed above to the first training scenario.

In addition to constructing the instruction, we also tried it on trainees. The results of this use of the instruction will be discussed in the next section.

Evaluation of Training

The evaluation of the training package was completed at Fort Hood, TX, with four officers of the 1st Cavalry Division, 1 HBCT staff, and Fort Leavenworth, KS, with three battalion command selects and one brigade command select from School of Command Preparation. The introduction to the visualization skills and the Road to War were sent in advance as read-ahead packets to make the most of the time provided by the trainees. The officers evaluating the training were informally interviewed before, during, and after the training to provide feedback on the different sections of the training package. Overall, the individuals who went through the visualization training thought it was a valuable training tool for teaching visualization—an important training need for the Army. They felt it should be further developed into a complete training application to be used throughout the Army.

One theme that was clear throughout the evaluation was that visualization is not a skill well understood. Therefore, the individuals being evaluated had many different opinions/ recommendations on improving the training that sometimes contradicted one another. The input that was gathered from the evaluation at Fort Hood was evaluated by the SMEs and where feasible the training was revised prior to the Fort Leavenworth evaluation.

Table 1

Linking Build 1: Instruction TSP to instructional rationale

Slide(s)	Description	Rationale or principle
3	Introduction to visualization training	Motivates and introduces instruction to students
4	Introduction to the visualization process	Begins to describe what the visualization process is
5	Describes how the four layers are applied by experts in an integrated fashion, and in parallel with other skills and knowledge	
6	Describes how four layers are divided into 11 skills	Didactic instruction
7-17	Describes each of the 11 skills.	Didactic instruction
18-21	Introduction and presentation of METT-TC and EOD	Background knowledge
22	Re-present integration diagram of Visualization with other knowledge	Connective presentation material
23	Introduction to Training Module and training processed used train the visualization skills	Background knowledge
24-45	Road to War	Background on Iraq
46-50	Friendly/Enemy Update	
51-51	Rules of Engagement	
56	Header of Battlefield visualization	Background on Brigade (or Battalion) AO
57	Briefings at RIP/TOA	
58	ISF cultural brief	
59-66	S-2 political brief	
67-71	Enemy TTP brief	
72	Patrol brief	
73	Civilian response brief	
74	Location for Vignette 1	
75	Intro to Vignette 1	Training scenario for crawl
76	Repeat Skill 1 Description	
77	Description of Build 1 application	
78-81	Scenario description and maps	
82	Demonstration of Build 1 by dynamic concept map (expert solution)	

The key revision made as a result of the Fort Hood evaluation was to include more explicit information about why the U.S. forces originally occupied the region and why U.S. forces were still there. Other revisions included some minor changes of words and correcting typing errors. The input received from Fort Leavenworth was also used to revise the training package. One major recommendation was to include a presentation of the skills defined in more common military terms for the audience to better understand. The officers completing the

training provided many recommendations and thoughts. Often the officers gave specific changes to the training package and at other times gave general comments. The following is a list to the main themes that were provided:

- The training serves a need in the Army and is a valuable tool that should be further developed. The prototype provided a good framework on which to continue the development.
- Presenting the vignettes with more visual aids to help portray the area better would help with the visualization.
- The presentation of the solutions was well received by the trainees, but most thought the animated presentation of the solution better communicated and illustrated the linkage between the cues and the commander's thoughts.
- The comments with regard to the visualization model were mostly positive. Participants were able to understand the concept and agreed with the principles. There were a couple of participants that thought it should be "dummied down" to the green suitors. It was suggested that the principles be consolidated, with the four synchronize principles being combined into one principle.
- The Road to War was on target and they were able to correlate the training AO with the AO they could expect to see over in Iraq.
- Several officers thought the two mission statements should have been more specific, yet the former battalion commander who had commanded in Iraq stated he thought they were good.
- The build vignettes were very basic and several officers thought the process should have been introduced more at the beginning of the planning cycle.
- Several of the officers thought the solutions should involve more discussion of the lines of operations. The belief is the battalion operations cross over several logical lines of operations simultaneously and that they are interrelated.

Recommendations for Continuing the Training of Battalion Level Visualization

Recommendation 1. Consolidate the number of principles to reduce the amount of information a trainee must remember and master and base the training on well-founded findings from studies and research on complex cognitive functions.

Recommendation 2. Develop a comprehensive process model for each of the visualization skills.

Recommendation 3. Develop a complete training program to address each of the visualization skills. The training program should include a specification of a skill unit, followed by an evaluation of the trainees' performance on that unit. Based on the result of the evaluation, the training program should direct the trainee to remediation on that same skill, or the trainee is presented with new skill or a combination of skills. The relationship between skills should specify what skills were taught first, the order of subsequently presented skills, the scenarios in which they are taught, and most importantly, how evaluation of performance is going to guide the selection of remediation and focused instruction and practice.

Recommendation 4. Develop drills for the demonstration, rehearsal, and execution phases of training that would involve many more dynamic and interactive training presentations and interactions than were used in the proof of principle. This should include building training scenarios using a system with more interactive power than simple pages consisting mainly of text. Multimedia should be used to convey important information in ways that are motivating, engaging, and convey complex information, and enhance the learning experience. In addition, the training should provide visual representations that are available in net-centric environments.

Recommendation 5. Evaluate the effectiveness of the training with field studies. Both quantitative and qualitative measures should be used to assess overall effectiveness and to collect insights to improve the instruction.

Summary

The ability to visualize is an essential attribute that is critical to mission accomplishment. Currently, visualization is learned through a trial-and-error process with very few, if any, opportunities for formal training and instruction. That notion was confirmed in interviews with officers returning from Iraq and Afghanistan as a part of a cognitive task analysis to understand expert performance. Based on the results of the cognitive task analysis, an instructional process and proof-of-principle training products were developed and evaluated. The results clearly and unquestionably suggest that the Army needs to continue to develop training to address this key area of performance.

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Appendix A

Read Ahead Survey

BATTALION COMMANDER AND STAFF OFFICER
"Battlefield Thinking Skills"

Introduction

The U.S. Army Research Institute is conducting a research study on the types of thinking skills that commanders and key staff officers employ as part of visualizing operations within a complex battlespace. As part of this research, we have tentatively defined a set of thinking skills we believe to be relevant to this process. The purpose of this survey is to solicit your thoughts regarding each of these skills, based on your previous operational experience. Your answers will help us identify which of these skills are most important, which skills are employed most frequently, and which skills are the most difficult for you to perform. Findings from this research will lead to the development of training that can improve the ability of Army officers to employ these skills in future operations.

Outline of the Survey

This survey will present you with a series of thinking skill descriptions that have been identified from previous research. Each of these skills are thought to play some role in the process of (1) developing an understanding (*i.e.*, a "mental picture") of the battlespace and (2) visualizing how an operation will unfold in order to achieve mission objectives. For each of these skills, we will ask you to think about your past operational experience and then—based on this experience—subjectively rate each skill in terms of importance, frequency, and difficulty. In some cases, we will ask you to answer additional questions that will help us further define the nature of these skills. Please remember: **answers are neither right nor wrong in this survey.** We just want you to reflect on your own experience and give us your impression of how these skills played a role in developing an understanding of the battlespace and visualization of an operation.

Nature of the Battlefield Thinking Skills

We consider the process of developing an understanding of the battlespace to involve a range of battlefield thinking skills. Some of these skills are *cognitive* in nature –that is, they pertain to how you place available pieces of information within the context of your expertise in order to form a mental picture of the battlespace. Other skills are considered *social* in nature –that is, they pertain to how you collaborate with others in order to share insights and gain different perspectives on a situation. Still other skills are *ecological* in nature –that is, they pertain to how you initiate actions to manipulate the battlespace in order to gain further insight or reduce risk and uncertainty. **It is best to not consider these skills as being independent of one another.** Rather, they just reflect different aspects of your thought process that will influence the way in which you form a mental picture of the battlespace and the operations taking place within it.

Confidentiality

Responses to these questions will not be associated with any specific individuals. **Please do not mark any personal identifying information on this survey form.** After completing the main part of this survey, you will be asked to indicate merely (1) the type of command or staff assignment and (2) the type of operational context primarily associated with your responses. These answers will help us understand the degree to which use of these skills varies according to the role an officer plays within the military decision making process (MDMP) or with the degree of complexity and/or novelty of the operational environment.

You Are Encouraged to Make Notes

As you complete this survey, you are encouraged to make marginal notes on each page regarding either (1) questions you have about the skill definition or (2) past experiences brought to mind that are deemed relevant to a particular thinking skill. In a subsequent face-to-face interview, we will be asking you to recall example incidents from your past experience that illustrate these skills. During this interview, you will have the opportunity to refer back to these notes and use them to guide the discussions.

Thinking Skill 1: Framing the Decision Space

This skill pertains to how you use past knowledge and expertise to mentally frame or structure your interpretation of available pieces of information. On one level, you might use known *procedures* or *rules* to frame your situational understanding. At another level, you might think about the situation in terms of a familiar *sports metaphor*, *doctrinal principle*, or *analogy* drawn from some other aspect of your life. In each case, you are using some type of mental framework to (1) simplify and order your interpretation of the situation, (2) focus your attention, and (3) determine the relevance of different pieces of information. Novice level individuals often follow a set of rote rules or procedures in order to develop situation understanding and a plan of action. Intermediate experts might still rely upon rule sets to guide their thinking, but exhibit the ability to adapt these rules as necessary to each situation. More experienced individuals frame their thinking in a more holistic manner, applying fundamental metaphors, principles, or analogies as appropriate. At this level, it might be impossible to explain their reasoning in terms of rules or procedures because they simply no longer form the basis of their thinking.

Decision frameworks are usually built from *tacit* knowledge –that is, knowledge that is a natural part of your internal thinking and not written down in some formal manner. Pieces of this framework, however, are usually triggered (mentally activated in your mind) by certain cues or indicators from the operational situation. Thus, a specific aspect of the situation might remind you of a relevant procedure, a metaphor, an analogous experience, or some other mental model. Once triggered, this framework helps you interpret other pieces of information from the battlespace.

Relationship to Traditional MDMP

Framing the decision space occurs at the beginning of the MDMP as you establish the scope and parameters of the operation and develop command intent. Essentially, it lays the foundation for your overall vision of what is to be accomplished and how it will be accomplished. The decision framework defines the operational problem to be solved in order to achieve mission objectives. The use of metaphors, principles, or analogies allows this framework to be understood in terms that are familiar to your past experience.

Importance of This Skill to My Thinking

- ☐ 0 – This skill is ***not relevant*** in my thought process
- ☐ 1 – This skill has ***little impact*** on my thought process
- ☐ 2 – This skill has ***some impact*** on my thought process
- ☐ 3 – The skill has a ***moderate impact*** on my thought process
- ☐ 4 – This skill has a ***significant impact*** on my thought process
- ☐ 5 – This skill makes a ***critical impact*** on my thought process

Frequency of Using This Skill

- ☐ 0 – I ***never*** employ this skill
- ☐ 1 – I ***very seldom*** employ this skill
- ☐ 2 – I ***occasionally*** employ this skill
- ☐ 3 – I employ this skill about ***half the time***
- ☐ 4 – I ***frequently*** employ this skill
- ☐ 5 – I ***almost always*** employ this skill

Difficulty of Using This Skill

- ☐ 0 – I find this skill ***impossible*** to perform
- ☐ 1 – I have ***moderate difficulty*** performing this skill
- ☐ 2 – I perform this skill, but must give ***significant attention*** to it
- ☐ 3 – I perform this skill with ***deliberate, thoughtful attention***
- ☐ 4 – I perform this skill ***with ease, but am aware*** of doing it
- ☐ 5 – I perform this skill ***without consciously thinking*** about it

Type(s) of Mental Frameworks Most Often Used
(Check all that most frequently apply)

- ☐ Specific **rules** or **procedures** acquired through training
- ☐ Some type of **metaphor** from sports or other activity
- ☐ A **doctrinal principle** or lesson from military history
- ☐ An **informal "rule of thumb"** acquired through experience
- ☐ An **analogy** drawn from a similar past experience
- ☐ A mental model suggested to you by another individual
- ☐ Other _____

Thinking Skill 2: Defining Relevant Problem Elements

This skill pertains to how you mentally decompose the battlespace into meaningful problem elements. These elements extend from the highest level of abstract thought (*e.g.*, mission objects, command intent) down to the lowest level of visualizing concrete objects within the battlespace (*e.g.*, an enemy defensive position, a terrorist cell, a specific neighborhood religious leader). In some cases, you might also mentally associate problem elements at one level of thought with specific elements at another level of thought. For example, *mission objectives* might be associated with an adversary's *centers of gravity* or *centers of power* that (in your mind) reflect a decisive point of focus of the mission. Centers of gravity, in turn, might be mentally associated with specific desired *effects* or *endstates* to be achieved. Effects might be mentally associated with specific *actions* required to achieve those effects. Finally, actions might be associated with specific battlespace *nodes* or *objects* upon which they focus. Each of these examples—mission objectives, centers of gravity, effects, objects, etc.—represent elements of the problem space that are used to construct your mental picture or understanding of the battlespace.

It is possible that each individual might mentally decompose the battlespace differently, using problem elements that are familiar to them. In other cases, members of a command group might agree on a standard definition of these elements. In either case, they will mentally structure these elements in a way that allows them to simplify and highlight the important connections that relate specific actions and effects to higher level command intent. In a complex type of stability and reconstruction operation, these elements can often be defined across multiple dimensions of the battlespace –*e.g.*, political, military, economic, social, cultural, information, etc. Of course, an individual's ability to think across each of these dimensions is limited by their particular areas and level of expertise.

Relationship to Traditional MDMP

Defining the relevant problem elements is part of building your overall course of action. This skill fills in the details of the decision framework by decomposing the assigned mission into the commander's mission analysis, lines of operation, effects, target lists, and required and implied tasks. The commander is primarily involved in defining the higher (more abstract) elements of the problem space, while lower details are typically developed by the staff. Taken as a whole, the hierarchy of problem elements must logically provide a strategy for achieving command intent.

Importance of This Skill to My Thinking

- ☐ 0 – This skill is ***not relevant*** in my thought process
- ☐ 1 – This skill has ***little impact*** on my thought process
- ☐ 2 – This skill has ***some impact*** on my thought process
- ☐ 3 – The skill has a ***moderate impact*** on my thought process
- ☐ 4 – This skill has a ***significant impact*** on my thought process
- ☐ 5 – This skill makes a ***critical impact*** on my thought process

Frequency of Using This Skill

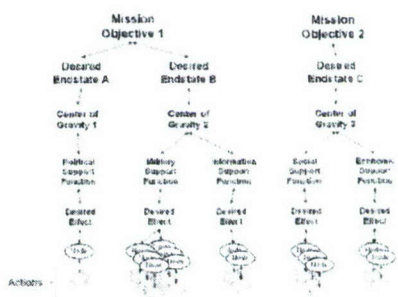
- ☐ 0 – I ***never*** employ this skill
- ☐ 1 – I ***very seldom*** employ this skill
- ☐ 2 – I ***occasionally*** employ this skill
- ☐ 3 – I employ this skill about ***half the time***
- ☐ 4 – I ***frequently*** employ this skill
- ☐ 5 – I ***almost always*** employ this skill

Difficulty of Using This Skill

- ☐ 0 – I find this skill ***impossible*** to perform
- ☐ 1 – I have ***moderate difficulty*** performing this skill
- ☐ 2 – I perform this skill, but must give ***significant attention*** to it
- ☐ 3 – I perform this skill with ***deliberate, thoughtful attention***
- ☐ 4 – I perform this skill ***with ease, but am aware*** of doing it
- ☐ 5 – I perform this skill ***without consciously thinking*** about it

Type(s) of Problem Elements Most Often Used
(Check all that most frequently apply)

- ☐ **Mission object** or **desired endstate**
- ☐ **Center of gravity, center of power, center of vulnerability**
- ☐ **Function** supporting a center of gravity (e.g., political)
- ☐ **Effect** (taken against a node/object)
- ☐ Battlespace **node** or **object**
- ☐ **Operational constraint, rule-of-engagement**
- ☐ Other _____



Thinking Skill 3: Defining Operational Pathways

This skill pertains to how you mentally visualize one or more operational pathways that enable you to move from the current state of the battlespace toward a set of desired endstates. These pathways extend over time; hence, there is a chronological sequence typically involved. However, these pathways can also be envisioned in terms of a series of operational issues or axes. Each issue or axis might be mentally defined in terms of one or more obstacles that block success of the mission, the strategy or actions needed to overcome these obstacles, and the critical events or decision points associated with each strategy. Actions might either be assigned or implied by the mission objectives.

Whereas Skill 2 deals with how you decompose the battlespace in terms of problem elements, this skill involves piecing these elements together in terms of causal relationships. This skill also involves the ability to project actions into the future and to predict their likely ability to bring about desired effects and influences on higher level problem elements (*e.g.*, centers of gravity). Holistically, this skill represents the ability of an individual to envision an operation from beginning to end. As mentioned earlier with problem elements, each individual might mentally construct these pathways in a unique manner –or, members of a command group might agree on a standard way of explicitly defining them in terms of a formal PERT chart or some other structure. Finally, it is noted that much of what is reflected in this skill area corresponds to the type of thinking typically reflected in course-of-action analyses and battle drills.

Relationship to Traditional MDMP

Defining the operational pathways can be thought of in terms of (1) establishing lines of operation, (2) identifying intermediate and final objectives along each line of operation, (3) identifying critical decision points, and (4) adjusting the sequencing of operations to achieve coordination. The details of each pathway will typically be discussed as part of war-gaming, synchronization meetings, and rock drills. Details of these discussions might also be documented in the form of synchronization matrices.

Importance of This Skill to My Thinking

- ☐ 0 – This skill is ***not relevant*** in my thought process
- ☐ 1 – This skill has ***little impact*** on my thought process
- ☐ 2 – This skill has ***some impact*** on my thought process
- ☐ 3 – The skill has a ***moderate impact*** on my thought process
- ☐ 4 – This skill has a ***significant impact*** on my thought process
- ☐ 5 – This skill makes a ***critical impact*** on my thought process

Frequency of Using This Skill

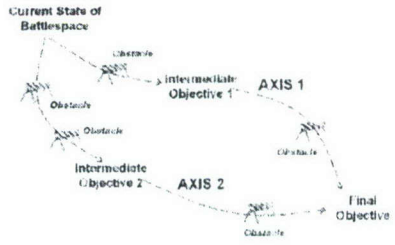
- ☐ 0 – I ***never*** employ this skill
- ☐ 1 – I ***very seldom*** employ this skill
- ☐ 2 – I ***occasionally*** employ this skill
- ☐ 3 – I employ this skill about ***half the time***
- ☐ 4 – I ***frequently*** employ this skill
- ☐ 5 – I ***almost always*** employ this skill

Difficulty of Using This Skill

- ☐ 0 – I find this skill ***impossible*** to perform
- ☐ 1 – I have ***moderate difficulty*** performing this skill
- ☐ 2 – I perform this skill, but must give ***significant attention*** to it
- ☐ 3 – I perform this skill with ***deliberate, thoughtful attention***
- ☐ 4 – I perform this skill ***with ease, but am aware*** of doing it
- ☐ 5 – I perform this skill ***without consciously thinking*** about it

Degree to Which Pathways Are Explicitly Defined
(Check all that most frequently apply)

- ☐ Pathways are **tacitly maintained** in an individual's head
- ☐ Pathways are formally defined as **axes of operation**
- ☐ Pathways are formally defined as a **course of action**
- ☐ Pathways are formally defined as a **synchronization matrix**
- ☐ Pathways are formally defined as **PERT chart**
- ☐ Other _____



Thinking Skill 4: Handling Risk and Uncertainty

This skill pertains to how you (1) identify which pieces of information are critically needed to validate your understanding of a situation or operation and (2) how you trade-off the value of missing information versus the time/cost of collecting or generating that information. This skill area presumes that command decisions are typically—if not always—made under conditions of uncertainty. The command group will not always know everything they would like to know about the battlespace or an unfolding operation. Hence, some individuals are likely to compensate for missing information by relying on specific assumptions—either consciously or unconsciously—about the battlespace. At the same time, other individuals might compensate for missing information by accounting for this uncertainty in their planning of actions and decisions.

Not all information is of equal value to the thinking process. Accordingly, this skill deals with the ability to assign relative value to missing elements of information, based on their role in validating or invalidating a held understanding of a situation. The skill also projects or estimates the time and cost of delaying actions or decisions while additional information is either collected or generated through staff analysis. Finally, the skill compensates for missing elements of critical information by incorporating this uncertainty into the planning and decision making process.

Risk and uncertainty in an operational situation can be considered in either an implicit or explicit manner, or it can be ignored. It is handled implicitly when an individual mentally accounts for these factors but does not formally communicate them to others. It is handled explicitly if risk and uncertainty are formally documented or communicated in the planning and decision making process. Ignoring risk and uncertainty often reflects a situation where an individual has relied too heavily on a specific mental model or other simplifying framework of interpretation.

Relationship to Traditional MDMP

The commander considers risk and uncertainty throughout the MDMP. Products of this aspect of thinking are typically reflected in Essential Elements of Information (EEIs), Priority Information Requirements (PIRs), Commander's Critical Information Requirements (CCIRs), and Areas of Interest (AIs). Areas of risk and uncertainty will also be reflected in the commander's "directed telescope" requests for information via reporting and LNOs.

Importance of This Skill to My Thinking

- ☐ 0 – This skill is ***not relevant*** in my thought process
- ☐ 1 – This skill has ***little impact*** on my thought process
- ☐ 2 – This skill has ***some impact*** on my thought process
- ☐ 3 – The skill has a ***moderate impact*** on my thought process
- ☐ 4 – This skill has a ***significant impact*** on my thought process
- ☐ 5 – This skill makes a ***critical impact*** on my thought process

Frequency of Using This Skill

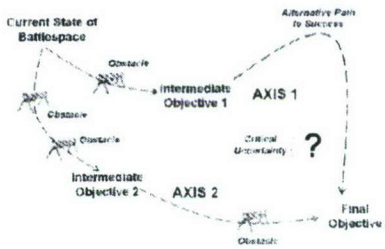
- ☐ 0 – I ***never*** employ this skill
- ☐ 1 – I ***very seldom*** employ this skill
- ☐ 2 – I ***occasionally*** employ this skill
- ☐ 3 – I employ this skill about ***half the time***
- ☐ 4 – I ***frequently*** employ this skill
- ☐ 5 – I ***almost always*** employ this skill

Difficulty of Using This Skill

- ☐ 0 – I find this skill ***impossible*** to perform
- ☐ 1 – I have ***moderate difficulty*** performing this skill
- ☐ 2 – I perform this skill, but must give ***significant attention*** to it
- ☐ 3 – I perform this skill with ***deliberate, thoughtful attention***
- ☐ 4 – I perform this skill ***with ease, but am aware*** of doing it
- ☐ 5 – I perform this skill ***without consciously thinking*** about it

Manner in Which Risk / Uncertainty Are Considered
(Check all that most frequently apply)

- ☐ Typically **ignored** because of over-reliance on mental model
- ☐ Assumed away through **simplifying assumptions**
- ☐ **Considered implicitly** in the development of understanding
- ☐ **Considered explicitly or formally in planning process**
- ☐ Used explicitly to **weigh time/cost** of additional information
- ☐ Used explicitly to **adjust actions and decisions**



Thinking Skill 5: Validating and Revising the Decision Framework

This skill pertains to how you use available information to either validate your existing decision framework or revise your framing of the decision space. It is a known characteristic of human decision makers that their initially formed impression (*i.e.*, mental model) of an operational situation will exert a strong influence on how they subsequently collect, perceive, and interpret information. Once formed, these initial impressions are often resistant to change –even in the face of conflicting or contradictory information. However, it is sometimes necessary to revise your mental framing of a situation if the contradictory information either (1) violates a previously held critical assumption or (2) suggests a more insightful way of framing the situation.

Command decision making is often accomplished under conditions of extreme uncertainty. Hence, much of the situational understanding will be based more on past experience rather than real-time information from the battlespace. Implicit in this form of thinking is the need to constantly test assumptions and mental models to determine if they still reflect an appropriate framework for decision making. This involves two complementary mental activities: (1) consciously seeking out information that validates a held assumption or mental model and (2) appropriately revising your assumptions and mental models when they no longer "fit" known facts or information from the battlespace. While this can be an exhaustive mental process, it is more often a process that involves focusing on selective cues or features of the operational situation. That is, each individual (based on their experience and expertise) will tend to focus on 3-5 salient cues or features that serve to validate a given understanding of the situation. If changes are detected in any of these cues or features, then this will trigger a process of questioning the validity of a specific assumption or mental model. Timely revision of assumptions and mental models can prevent the decision process from being "blind-sided."

Relationship to Traditional MDMP

The ability to adjust or revise your visualization of the battlespace reflects the traditional principle of "fight the enemy, not the plan." This skill is likely to be used later in the planning process (as more refined intelligence is gathered) or after operations have commenced execution.

Importance of This Skill to My Thinking

- ☐ 0 – This skill is ***not relevant*** in my thought process
- ☐ 1 – This skill has ***little impact*** on my thought process
- ☐ 2 – This skill has ***some impact*** on my thought process
- ☐ 3 – The skill has a ***moderate impact*** on my thought process
- ☐ 4 – This skill has a ***significant impact*** on my thought process
- ☐ 5 – This skill makes a ***critical impact*** on my thought process

Frequency of Using This Skill

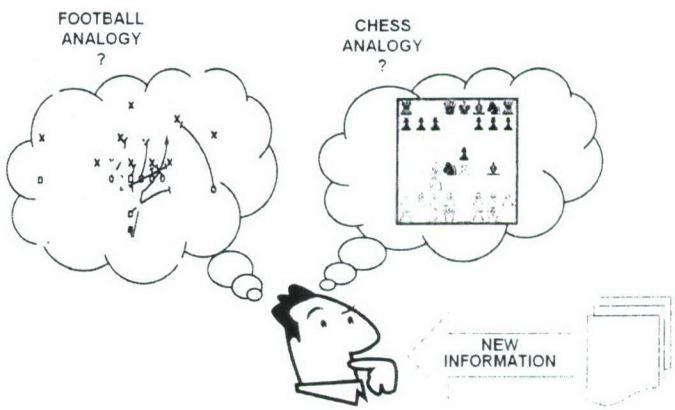
- ☐ 0 – I ***never*** employ this skill
- ☐ 1 – I ***very seldom*** employ this skill
- ☐ 2 – I ***occasionally*** employ this skill
- ☐ 3 – I employ this skill about ***half the time***
- ☐ 4 – I ***frequently*** employ this skill
- ☐ 5 – I ***almost always*** employ this skill

Difficulty of Using This Skill

- ☐ 0 – I find this skill ***impossible*** to perform
- ☐ 1 – I have ***moderate difficulty*** performing this skill
- ☐ 2 – I perform this skill, but must give ***significant attention*** to it
- ☐ 3 – I perform this skill with ***deliberate, thoughtful attention***
- ☐ 4 – I perform this skill ***with ease, but am aware*** of doing it
- ☐ 5 – I perform this skill ***without consciously thinking*** about it

Manner in Which Conflicting Information Is Handled
(Check all that most frequently apply)

- ☐ Typically **ignored** because of over-reliance on mental model
- ☐ Assumed away through **simplifying assumptions**
- ☐ **Considered implicitly** in the continued use of a mental model
- ☐ **Considered explicitly or formally** in planning process
- ☐ Used explicitly to **adjust assumptions and mental models**
- ☐ Used explicitly to **adjust actions and decisions**



Thinking Skill 6: Forming the Critical Process of Collaboration

Framing a decision space—sometimes referred to as "sensemaking"—is rarely an individual process in most organizations. Rather, it is often a collaborative or negotiated process, with different experts and stakeholders contributing their unique knowledge and perspective on the operational situation. While it is true that a military commander is ultimately responsible for this process—and to a large extent mentally shapes this process—he will nevertheless seek out and consider other points of view. A critical aspect of this process is identifying who should participate in the integration, negotiation, and reconciliation of the different viewpoints and areas of expertise. Not having the right expertise or viewpoint represented can leave the organization vulnerable to overlooking some critical aspect or dimension of the operation. Having too many participants collaborate can unnecessarily complicate and delay the process.

Another aspect of collaboration is the manner in which participants are encouraged or permitted to contribute. An authoritarian model of collaboration is one which is dominated by a single individual –usually the ranking military officer. Such a model often inhibits other individuals from contributing, even though they might hold a critical piece of information or reflect a critical area of relevant expertise. A democratic model of collaboration is one which each participant proactively contributes according to their relative areas of expertise. The important thing to remember is that there is no single "correct" model of collaboration. Rather, the form or mode of collaboration must be adapted to the needs of the situation. Time pressure generally tends to limit the amount of collaboration, thus reducing the process to an authoritarian model. On the other hand, situational complexity tends to increase the need for collaboration –thus leading to a more democratic or participatory model. Forming the critical process of collaboration is not purely a "cognitive" skill *per se*; rather it involves a certain degree of social skill as well.

Relationship to Traditional MDMP

Forming the process of collaboration typically occurs over a period of time prior to the actual start of the planning process. This skill involves the commander assessing the expertise and judgment of his staff officers, establishing his unique battle rhythm, directing who should be involved at each step in the unit's MDMP, and offering guidance as to who should talk with whom across the various digital and voice networks of communication.

Importance of This Skill to My Thinking

- ☐ 0 – This skill is ***not relevant*** in my thought process
- ☐ 1 – This skill has ***little impact*** on my thought process
- ☐ 2 – This skill has ***some impact*** on my thought process
- ☐ 3 – The skill has a ***moderate impact*** on my thought process
- ☐ 4 – This skill has a ***significant impact*** on my thought process
- ☐ 5 – This skill makes a ***critical impact*** on my thought process

Frequency of Using This Skill

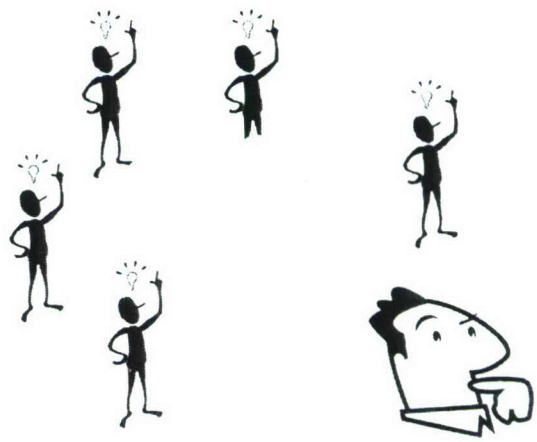
- ☐ 0 – I ***never*** employ this skill
- ☐ 1 – I ***very seldom*** employ this skill
- ☐ 2 – I ***occasionally*** employ this skill
- ☐ 3 – I employ this skill about ***half the time***
- ☐ 4 – I ***frequently*** employ this skill
- ☐ 5 – I ***almost always*** employ this skill

Difficulty of Using This Skill

- ☐ 0 – I find this skill ***impossible*** to perform
- ☐ 1 – I have ***moderate difficulty*** performing this skill
- ☐ 2 – I perform this skill, but must give ***significant attention*** to it
- ☐ 3 – I perform this skill with ***deliberate, thoughtful attention***
- ☐ 4 – I perform this skill ***with ease, but am aware*** of doing it
- ☐ 5 – I perform this skill ***without consciously thinking*** about it

Manner in Which Collaborative Groups Are Formed
(Check all that most frequently apply)

- ☐ Typically **ignored** or not consciously addressed
- ☐ Assumed away through **simplifying operating procedures**
- ☐ **Considered implicitly** in the framing of the decision space
- ☐ **Considered explicitly or formally** in planning process
- ☐ Collaboration **dictated by commander style/personality**
- ☐ Collaboration **adjusted according to needs of situation**



Thinking Skill 7: Focusing on Critical Linkages and Relationships

This skill pertains to how you search for, identify, and evaluate critical linkages and relationships across different dimensions of the decision space. Command teams must often consider multiple dimensions of the battlespace simultaneously. Recent experience has demonstrated the need to consider military operations in the context of relevant political, economic, social, cultural, religious, information, and infrastructure factors –many of which are beyond the immediate control of the unit or organization. Often, an action taken along one dimension of the battlespace will have rippling effects across other dimensions. If these second-order—and sometimes unintended—consequences are not factored into the framing of the decision space, then unexpected results can arise from the actions taken by the organization.

This skill builds upon Thinking Skill 6 inasmuch as complex operations will demand a certain level of collaboration among experts and stakeholders who understanding different aspects or dimensions of the situation. If relevant areas of information or knowledge are not represented in the framing of the decision space, then it will be difficult to identify important elements of the situation. Assuming that each area of relevant information and knowledge is represented in the collaboration process, this skill addresses the ability to employ these different areas of expertise in order to identify and highlight important interactions among the different dimensions of the battlespace. Sensitivity to other points of view and the ability to mentally transpose analogies and models from one domain to another domain are critical elements of this thinking skill. This skill also relates to Thinking Skill 2 since it provides the ability to visualize critical linkages and relationships among the framework of problem elements.

Importance of This Skill to My Thinking

- ☐ 0 – This skill is ***not relevant*** in my thought process
- ☐ 1 – This skill has ***little impact*** on my thought process
- ☐ 2 – This skill has ***some impact*** on my thought process
- ☐ 3 – The skill has a ***moderate impact*** on my thought process
- ☐ 4 – This skill has a ***significant impact*** on my thought process
- ☐ 5 – This skill makes a ***critical impact*** on my thought process

Frequency of Using This Skill

- ☐ 0 – I ***never*** employ this skill
- ☐ 1 – I ***very seldom*** employ this skill
- ☐ 2 – I ***occasionally*** employ this skill
- ☐ 3 – I employ this skill about ***half the time***
- ☐ 4 – I ***frequently*** employ this skill
- ☐ 5 – I ***almost always*** employ this skill

Difficulty of Using This Skill

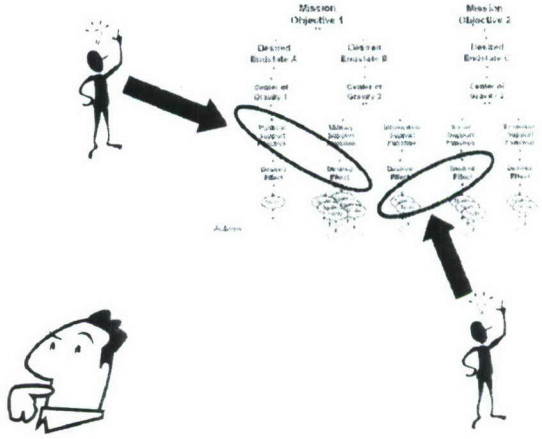
- ☐ 0 – I find this skill ***impossible*** to perform
- ☐ 1 – I have ***moderate difficulty*** performing this skill
- ☐ 2 – I perform this skill, but must give ***significant attention*** to it
- ☐ 3 – I perform this skill with ***deliberate, thoughtful attention***
- ☐ 4 – I perform this skill ***with ease, but am aware*** of doing it
- ☐ 5 – I perform this skill ***without consciously thinking*** about it

Focusing on Critical Linkages and Relationships
(Check all that most frequently apply)

- ☐ Typically **ignored** or not consciously addressed
- ☐ Assumed away through **simplifying mental models**
- ☐ **Considered implicitly** in the framing of the decision space
- ☐ **Considered explicitly or formally** in planning process
- ☐ Linkages/relationships **formally related to problem elements**
- ☐ Linkages/relationships **influence formation of collaboration process**

Relationship to Traditional MDMP

Focusing on critical linkages and relationships has become increasingly more important in stability and reconstruction operations. It is also an important element of effects-based operations, regardless of the operational environment. Thinking about linkages and relationships has always been a part of the MDMP. However, the increased emphasis on political, economic, social, cultural, religious, information, and infrastructure dimensions of the battlespace make it imperative that the commander consider the cross-linkage of actions and effects in order to avoid unanticipated negative consequences.



Thinking Skill 8: Identifying and Resolving Collaboration Barriers

This skill pertains to your ability to identify and resolve specific barriers that might arise to inhibit effective collaboration among relevant experts and stakeholders. This process begins with a holistic assessment of the decision space to identify areas of understanding that appear to be undeveloped or inadequately developed. Here, particular attention is paid to the critical linkages and relationships identified (or that should be identified) by Thinking Skill 7 across the various dimensions of the battlespace. Next, the process identifies the perspectives or types of expertise likely to be needed in order to more fully develop these areas of understanding. Next, the process identifies the potential reasons (barriers) for why these perspectives or areas of expertise are not adequately represented or considered in the framing of the decision space. Finally, the process determines the best (most expedient) method for eliminating or overcoming the identified barriers.

Barriers to effective collaboration can include a number of different categories. *Cognitive barriers* include (1) use of specialized vocabularies or jargon, (2) lack of familiarity with another area of expertise, and (3) lack of familiarity with the area of operation. *Social* or *organizational barriers* include (1) lack of interpersonal trust, (2) parochial boundaries, (3) inflexible procedures and routines and (4) time-stressed battle rhythm. *Technical barriers* include (1) network capacity or unreliability and (2) lack of effective collaboration tools.

It is important to recognize that many of these barriers might be "systemic" –*i.e.*, they develop or exist over a period of time and become an enduring part of the organization. However, if they are recognized as having a detrimental impact on the ability of relevant experts and stakeholders to collaborate, then it is important that they be addressed in a timely manner.

Relationship to Traditional MDMP

The identification and resolution of collaboration barriers is a process that continually refines or hones the unit's battle rhythm into an efficient planning and execution system. Different types of collaboration barriers will involve different resolution mechanisms and timelines –*e.g.*, staff training, personnel reassignments, feedback provided during unit briefings, implementation of different TTPs/SOPs, and introduction of various digital information networks and collaboration tools.

Importance of This Skill to My Thinking

- ☐ 0 – This skill is ***not relevant*** in my thought process
- ☐ 1 – This skill has ***little impact*** on my thought process
- ☐ 2 – This skill has ***some impact*** on my thought process
- ☐ 3 – The skill has a ***moderate impact*** on my thought process
- ☐ 4 – This skill has a ***significant impact*** on my thought process
- ☐ 5 – This skill makes a ***critical impact*** on my thought process

Frequency of Using This Skill

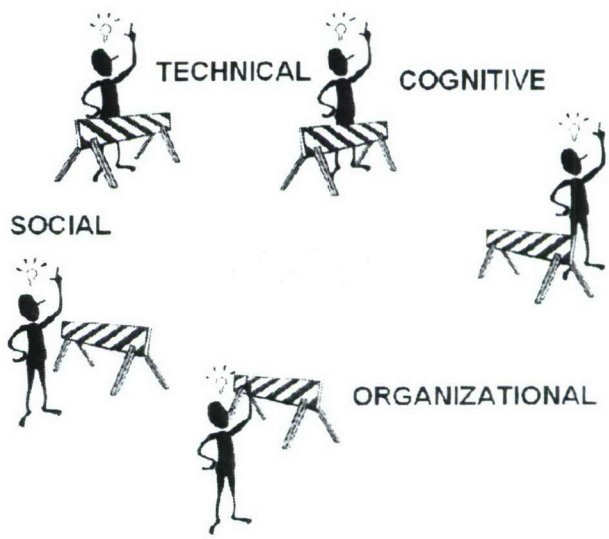
- ☐ 0 – I ***never*** employ this skill
- ☐ 1 – I ***very seldom*** employ this skill
- ☐ 2 – I ***occasionally*** employ this skill
- ☐ 3 – I employ this skill about ***half the time***
- ☐ 4 – I ***frequently*** employ this skill
- ☐ 5 – I ***almost always*** employ this skill

Difficulty of Using This Skill

- ☐ 0 – I find this skill ***impossible*** to perform
- ☐ 1 – I have ***moderate difficulty*** performing this skill
- ☐ 2 – I perform this skill, but must give ***significant attention*** to it
- ☐ 3 – I perform this skill with ***deliberate, thoughtful attention***
- ☐ 4 – I perform this skill ***with ease, but am aware*** of doing it
- ☐ 5 – I perform this skill ***without consciously thinking*** about it

Identifying and Resolving Collaboration Barriers
(Check all that most frequently apply)

- ☐ Typically **ignored** or not consciously addressed
- ☐ Assumed away through **organizational SOPs/TTPs**
- ☐ **Considered implicitly** during the planning process
- ☐ **Considered explicitly or formally** during planning process
- ☐ Barriers **formally identified**
- ☐ Barriers **formally resolved**



Thinking Skill 9: Monitoring / Adjusting the Knowledge Management Process

This skill pertains to your ability to monitor and adjust the overall knowledge management and decision making process according to the nature of the operational environment. The skill presumes that different levels of situation complexity and ambiguity demand different sensemaking strategies. These levels can be defined as

- ***Known Situation*** Cause/effect linkages are fully known, empirically testable, and predictable or familiar. Once situation is properly classified, standard tactics and procedures are used to efficiently achieve results. Focus on detecting when standard responses no longer fit situation.
- ***Knowable Situation*** Cause/effect linkages are familiar and knowable, but require investment of time and resources to become fully known. Analysis and fact-finding are used to reveal cause/effect linkages and classify situation. Focus on managing cost/time of analysis and fact-finding.
- ***Complex Situation*** Cause/effect linkages are unique to situation and unrepeatable. Hence, situations defy familiar classification. Probes must be employed to discover patterns so that desirable patterns can be reinforced and negative patterns can be destabilized. Focus on discovering and exploiting meaningful patterns and trends.
- ***Chaotic Situation*** Cause/effect linkages and patterns are difficult to perceive. Interventions must be initiated to reduce turbulence and stabilize situation to the point where probes can reveal meaningful patterns. Crisis management takes precedence over deliberate planning. Focus on managing the level of situational turbulence.

Failure to properly characterize the nature of the operational environment and adjust the knowledge management process is likely to lead to catastrophic collapse of situational understanding.

Importance of This Skill to My Thinking

- ☐ 0 – This skill is ***not relevant*** in my thought process
- ☐ 1 – This skill has ***little impact*** on my thought process
- ☐ 2 – This skill has ***some impact*** on my thought process
- ☐ 3 – The skill has a ***moderate impact*** on my thought process
- ☐ 4 – This skill has a ***significant impact*** on my thought process
- ☐ 5 – This skill makes a ***critical impact*** on my thought process

Frequency of Using This Skill

- ☐ 0 – I ***never*** employ this skill
- ☐ 1 – I ***very seldom*** employ this skill
- ☐ 2 – I ***occasionally*** employ this skill
- ☐ 3 – I employ this skill about ***half the time***
- ☐ 4 – I ***frequently*** employ this skill
- ☐ 5 – I ***almost always*** employ this skill

Difficulty of Using This Skill

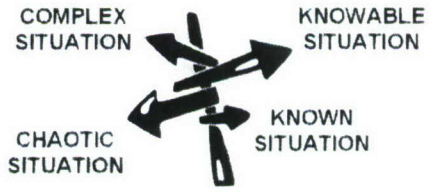
- ☐ 0 – I find this skill ***impossible*** to perform
- ☐ 1 – I have ***moderate difficulty*** performing this skill
- ☐ 2 – I perform this skill, but must give ***significant attention*** to it
- ☐ 3 – I perform this skill with ***deliberate, thoughtful attention***
- ☐ 4 – I perform this skill ***with ease, but am aware*** of doing it
- ☐ 5 – I perform this skill ***without consciously thinking*** about it

Monitoring / Adjusting Knowledge Mgmt Process
(Check all that most frequently apply)

- ☐ Typically **ignored** or not consciously addressed
- ☐ Assumed away through **organizational SOPs/TTPs**
- ☐ **Considered implicitly** during the planning process
- ☐ **Considered explicitly or formally** during planning process
- ☐ Situation complexity/ambiguity level **formally identified**
- ☐ Knowledge mgmt process **formally adjusted** to match need

Relationship to Traditional MDMP

Traditional combat operations against a regular military unit presume a *Known* or *Knowable* operational situation in which the commander and his staff apply a familiar battle calculus to plan and execute operations. Decisions regarding the cost/time of collecting and analyzing additional intelligence are part of the normal tradeoffs made during the MDMP. Stability and reconstruction operations typically reflect more of a *Complex* or *Chaotic* situation in which the commander must adjust his strategy and battle rhythm to a more fluid style, involve a wider range of expertise, and compensate for the unique/novel and often turbulent environment.



Thinking Skill 10: Articulating and Communicating Actionable Knowledge

This skill pertains to your ability to translate an internal or implicit understanding of the situation and operational plan (actionable knowledge) into an explicit form that can be effectively communicated to others. Much of the knowledge produced by the previously defined thinking skills is held internally in the minds of the commander and his key command group. In order to translate this knowledge into effective action, these various internally mental representations must be explicitly articulated in a way that can be effectively communicated to others. Implied in this skill is the ability to verbally or graphically express the envisioned decision space in meaningful terms or diagrams. Considered from the point of view of relevant problem elements (Thinking Skill 2), it is relatively easy to identify and discuss battlespace objects and specific actions at the *concrete level* of thinking. This task becomes more challenging when one attempts to accurately describe support functions and effects at the *analytical level* of thinking. The task becomes even more challenging when one attempts to describe centers of gravity, desired endstates, and other problem elements at an *abstract level* of thinking. Nevertheless, effective articulation and communication at each level of thinking is a critical component of organizational sensemaking, planning, and decision making.

Actionable knowledge can be articulated and communicated through a variety of means, including formal operational plans and orders, synchronization matrices, war gaming and rock drill discussions, networked collaboration tools (*e.g.*, whiteboards), sidebar discussions, and networked messages (either verbal or digital). Where actionable knowledge is codified and preserved in written form, it is essential that embedded assumptions and models critical to the understanding be appropriately documented. Where actionable knowledge is communicated in verbal form, it is essential that recipients are able to accurately repeat back their understanding to insure that the critical elements of knowledge are correctly communicated.

Importance of This Skill to My Thinking

- ☐ **0** – This skill is ***not relevant*** in my thought process
- ☐ **1** – This skill has ***little impact*** on my thought process
- ☐ **2** – This skill has ***some impact*** on my thought process
- ☐ **3** – The skill has a ***moderate impact*** on my thought process
- ☐ **4** – This skill has a ***significant impact*** on my thought process
- ☐ **5** – This skill makes a ***critical impact*** on my thought process

Frequency of Using This Skill

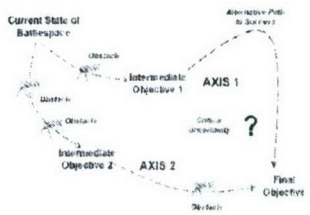
- ☐ **0** – I ***never*** employ this skill
- ☐ **1** – I ***very seldom*** employ this skill
- ☐ **2** – I ***occasionally*** employ this skill
- ☐ **3** – I employ this skill about ***half the time***
- ☐ **4** – I ***frequently*** employ this skill
- ☐ **5** – I ***almost always*** employ this skill

Difficulty of Using This Skill

- ☐ **0** – I find this skill ***impossible*** to perform
- ☐ **1** – I have ***moderate difficulty*** performing this skill
- ☐ **2** – I perform this skill, but must give ***significant attention*** to it
- ☐ **3** – I perform this skill with ***deliberate, thoughtful attention***
- ☐ **4** – I perform this skill ***with ease, but am aware*** of doing it
- ☐ **5** – I perform this skill ***without consciously thinking*** about it

Articulating/Communicating Actionable Knowledge
(Check all that most frequently apply)

- ☐ Knowledge verbally communicated at **concrete level**
- ☐ Knowledge verbally communicated at **analytical level**
- ☐ Knowledge verbally communicated at **abstract level**
- ☐ Knowledge communicated in writing at **concrete level**
- ☐ Knowledge communicated in writing at **analytical level**
- ☐ Knowledge communicated in writing at **abstract level**



The major axis of this operation focuses on the destruction of the ...

Relationship to Traditional MDMP

The communication of the commander's vision and intent is traditionally accomplished through written plans and orders and either verbal or written FRAGOs. Not formally described as part of the MDMP (but certainly something that has always been a part of the normal command process) are the myriad of other informal exchanges that serve to amplify or qualify these plans and orders.

Thinking Skill 11: Identifying / Adjusting Shaping Actions

This skill pertains to your ability to identify and adjust specific actions that serve to shape the battlespace in conformance with the mentally framed decision space. Making sense of an operational situation is not purely a passive mental activity –particularly in situations where thinking adversaries are attempting to impose their will on each other. Part of this process can also involve initiating actions that reduce critical areas of uncertainty and prepare the conditions for success. These are often called shaping actions inasmuch as they are a precursor to the decisive actions that culminate the operation. From the point of view of sensemaking, these actions serve to mold the reality of the battlespace to fit the assumptions and models used to frame the commander's decision space. This skill complements Thinking Skill 4 inasmuch as they both deal with the management of risk and uncertainty. Thinking Skill 4 manages risk in a more passive manner by mentally assessing the relative need for information within the commander's decision space. Thinking Skill 11 manages risk in a more proactive manner by initiating actions that physically foreclose or limit areas of risk and uncertainty within the commander's decision space.

Shaping actions are identified from a holistic analysis of the decision space –specifically, those aspects or areas of the decision space that reflect the largest degree of uncertainty or largest area of impact on the success of the planned mission. It is important when considering the planning and adjustment of shaping actions that attention be given to each dimension of the battlespace (*e.g.*, political, military economic, social, etc.) along with the critical linkages and relationships identified by Thinking Skill 7. This is necessary in order to avoid unanticipated negative consequences that might arise out of each specific action. Similarly, it is important to understand (and be able to trace) the impact of each shaping action upwards in the hierarchy of relevant problem elements identified by Thinking Skill 2. In this manner, it is possible to gain a sense of the relative importance or priority of each individual action.

Relationship to Traditional MDMP

Shaping actions have always been considered in the MDMP as a means of preparing the battlespace conditions for decisive action. This skill merely highlights the thinking that lies behind such actions as they are consciously and proactively employed to reduce risk and uncertainty in the operational plan.

Importance of This Skill to My Thinking

- ☐ 0 – This skill is ***not relevant*** in my thought process
- ☐ 1 – This skill has ***little impact*** on my thought process
- ☐ 2 – This skill has ***some impact*** on my thought process
- ☐ 3 – The skill has a ***moderate impact*** on my thought process
- ☐ 4 – This skill has a ***significant impact*** on my thought process
- ☐ 5 – This skill makes a ***critical impact*** on my thought process

Frequency of Using This Skill

- ☐ 0 – I ***never*** employ this skill
- ☐ 1 – I ***very seldom*** employ this skill
- ☐ 2 – I ***occasionally*** employ this skill
- ☐ 3 – I employ this skill about ***half the time***
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Difficulty of Using This Skill

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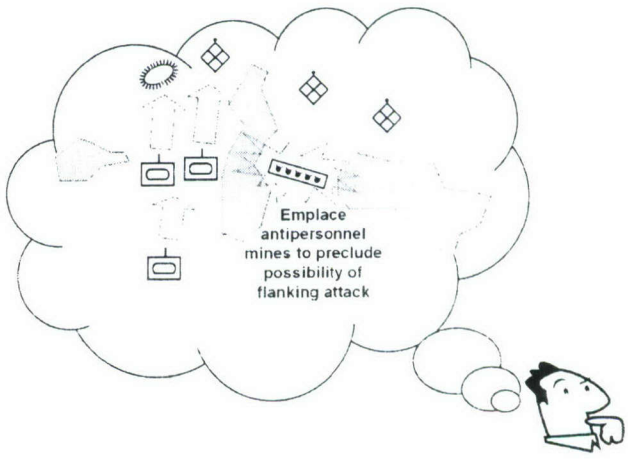
- ☐ 3 – I perform this skill with ***deliberate, thoughtful attention***
- ☐ 4 – I perform this skill ***with ease, but am aware*** of doing it
- ☐ 5 – I perform this skill ***without consciously thinking*** about it

Identifying / Adjusting Shaping Actions
(Check all that most frequently apply)

- ☐ Shaping actions are generally **not considered**
- ☐ Shaping actions are **defined primarily by standard TTPs**
- ☐ Shaping actions are **implicitly considered** in planning
- ☐ Shaping actions are **defined by areas of uncertainty**
- ☐ Shaping actions are **monitored** to insure desired impact
- ☐ Shaping actions are **prioritized by mission impact**



Thinking Skill 12: Identifying / Adjusting Probing Actions

This skill pertains to your ability to identify and adjust specific actions that serve to probe the battlespace. These actions are taken to stimulate responses within the battlespace that can reveal or illuminate hidden linkages and relationships relevant to either the adversary or the operating environment. Once revealed, these linkages and relationships can be subsequently exploited for operational advantage (described next as part of Thinking Skill 13). As such, the use of probing actions represents a proactive form of sensemaking, one in which the commander is actively causing the adversary or operational environment to reveal its hidden dynamics.

The need for probing actions is particularly great in those types of operations characterized by multiple, non-military battlespace dimensions –*e.g.*, political, economic, social, cultural, etc. In such cases, decision makers might not possess relevant experience along one or more of these dimensions, or the novelty of the situation might preclude the application of past experience. Probing actions tend to compensate for the lack of a known "battle calculus" or set of mental models from which to operate against these non-military dimensions. In a sense, decision makers are building their own "battle calculus" through direct manipulation of the battlespace. Because the commander is operating in a cycle of discovery and exploitation, the use of probing actions might mistakenly be labeled a "trial-and-error" approach to planning and execution. However, if employed in a deliberate fashion within the context of operational objectives, probing actions—and the subsequent exploitation of what these actions reveal—represent a skillful approach to sensemaking in a complex operational environment. Such an approach requires conscious planning of both the probing actions and the strategy or means by which meaningful feedback information will be collected.

Relationship to Traditional MDMP

The use of probing actions relates to the traditional MDMP in two ways: (1) the use of armed reconnaissance to force an adversary to reveal and commit his forces and (2) the development of branches and sequels in the planning process. This skill extends this idea to the more complex and chaotic environment often associated with stability and reconstruction operations. In this case, the commander must employ a more incremental approach to revealing adversary weaknesses and other opportunities for exploitation across the multiple dimensions of the battlespace.

Importance of This Skill to My Thinking

- ☐ 0 – This skill is ***not relevant*** in my thought process
- ☐ 1 – This skill has ***little impact*** on my thought process
- ☐ 2 – This skill has ***some impact*** on my thought process
- ☐ 3 – The skill has a ***moderate impact*** on my thought process
- ☐ 4 – This skill has a ***significant impact*** on my thought process
- ☐ 5 – This skill makes a ***critical impact*** on my thought process

Frequency of Using This Skill

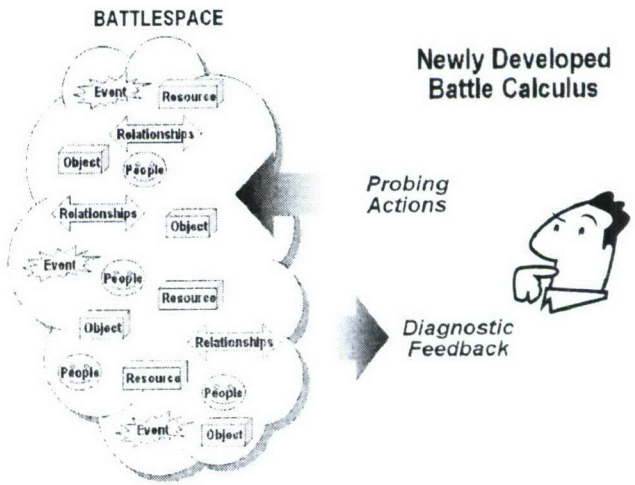
- ☐ 0 – I ***never*** employ this skill
- ☐ 1 – I ***very seldom*** employ this skill
- ☐ 2 – I ***occasionally*** employ this skill
- ☐ 3 – I employ this skill about ***half the time***
- ☐ 4 – I ***frequently*** employ this skill
- ☐ 5 – I ***almost always*** employ this skill

Difficulty of Using This Skill

- ☐ 0 – I find this skill ***impossible*** to perform
- ☐ 1 – I have ***moderate difficulty*** performing this skill
- ☐ 2 – I perform this skill, but must give ***significant attention*** to it
- ☐ 3 – I perform this skill with ***deliberate, thoughtful attention***
- ☐ 4 – I perform this skill ***with ease, but am aware*** of doing it
- ☐ 5 – I perform this skill ***without consciously thinking*** about it

Identifying / Adjusting Probing Actions
(Check all that most frequently apply)

- ☐ Probing actions are generally **not considered**
- ☐ Probing actions are **defined primarily by standard TTPs**
- ☐ Probing actions are **implicitly considered** in planning
- ☐ Probing actions are **defined by areas of uncertainty**
- ☐ Specific steps are taken to **collect meaningful feedback**
- ☐ Specific steps are taken to **refine the "battle calculus"**



Thinking Skill 13: Discovery / Exploitation of Opportunities

This skill pertains to your ability to diagnose (in near-real time) feedback from the battlespace in order to identify and exploit adversary weaknesses and other emerging opportunities for operational advantage. This aspect of thinking underscores the almost continuous nature of sensemaking in a dynamic operational environment. This skill is particularly relevant in complex or chaotic situations involving the emergence of novel or unique linkages and relationships within the battlespace. Implied in the definition of this skill is the notion that military commanders must frequently take the initiative and act without a complete understanding of the dynamics involved in a given situation. As these dynamics become revealed through either chance opportunity or by deliberate probing actions (Thinking Skill 12), newly developed operational insights can be used to identify new problem elements (Thinking Skill 2), construct new pathways to success (Thinking Skill 3), and reframe the decision space (Thinking Skill 5).

Implied in this skill is the need to be constantly vigilant regarding the emergence of previously unknown linkages and relationships that can span multiple dimensions of the battlespace. At the same time, it is imperative that an open mind be kept regarding the framing of the decision space – *i.e.*, that decision makers not be mentally locked into a rigid mental model of the battlespace or the unfolding operation. Timely discovery and exploitation of emerging insights will not generally occur without key decision makers formally factoring this aspect of thinking into the monitoring and adjustment of on-going operations. This implies the need to assess the overall decision space in terms of areas or aspects of the operation that are likely to yield new insights as the operation progresses. Additionally, it also implies the need for decision makers to be prepared to systematically assess these insights and translate them into actionable knowledge (Thinking Skills 2 and 3).

Relationship to Traditional MDMP

The discovery and exploitation of emerging opportunities during an operation has always been part of effect command –usually accomplished during the execution phase of an operation. This reflects the military principle that the commander should "fight the enemy, not the plan." This skill merely highlights the thinking the lies behind this principle. During stability and reconstruction operations, this process is more of a continual one, rather than one confined to a specific step of the MDMP.

Importance of This Skill to My Thinking

- ☐ 0 – This skill is ***not relevant*** in my thought process
- ☐ 1 – This skill has ***little impact*** on my thought process
- ☐ 2 – This skill has ***some impact*** on my thought process
- ☐ 3 – The skill has a ***moderate impact*** on my thought process
- ☐ 4 – This skill has a ***significant impact*** on my thought process
- ☐ 5 – This skill makes a ***critical impact*** on my thought process

Frequency of Using This Skill

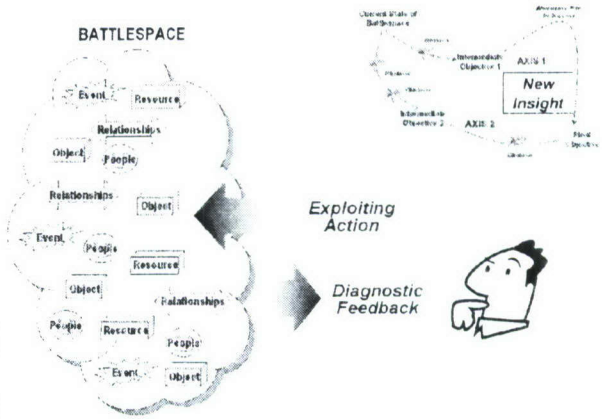
- ☐ 0 – I ***never*** employ this skill
- ☐ 1 – I ***very seldom*** employ this skill
- ☐ 2 – I ***occasionally*** employ this skill
- ☐ 3 – I employ this skill about ***half the time***
- ☐ 4 – I ***frequently*** employ this skill
- ☐ 5 – I ***almost always*** employ this skill

Difficulty of Using This Skill

- ☐ 0 – I find this skill ***impossible*** to perform
- ☐ 1 – I have ***moderate difficulty*** performing this skill
- ☐ 2 – I perform this skill, but must give ***significant attention*** to it
- ☐ 3 – I perform this skill with ***deliberate, thoughtful attention***
- ☐ 4 – I perform this skill ***with ease, but am aware*** of doing it
- ☐ 5 – I perform this skill ***without consciously thinking*** about it

Discovering / Exploiting Opportunities
(Check all that most frequently apply)

- ☐ Operational insights are generally **not considered**
- ☐ Operational insights are **implicitly considered** in replanning
- ☐ Monitoring of operations **anticipates** operational insights
- ☐ **Specific steps** are taken to **develop** operational insights
- ☐ **Specific steps** are taken to **exploit** operational insights



Response Classification

Please indicate (1) the type of command or staff assignment and (2) the type of operational context primarily associated with your responses. These answers will help us understand the degree to which use of these skills varies according to the role an officer plays within the military decision making process (MDMP) or with the degree of complexity and/or novelty of the operational environment.

Do not mark any personal identifying information on this survey form.

Most Relevant Command or Staff Assignment

- ☐ Battalion Commander
- ☐ Battalion XO
- ☐ Battalion S-3
- ☐ Other (Specify) _____

Most Relevant Operational Context

- ☐ Major combat operations (against regular military unit)
- ☐ Major combat operations (against insurgency unit)
- ☐ Stability / peacekeeping operations
- ☐ Urban operations
- ☐ National Training Center
- ☐ Other (Specify) _____

Additional Comments

Please provide any amplifying comments, suggestions for additional skill definitions, or other comments in the space provided below.

Thank You for Your Time and Attention!

Appendix B

Interview Protocol

BATTALION COMMANDER AND STAFF OFFICER INTERVIEW GUIDE

STEP 1: INTRODUCE PURPOSE AND SCOPE OF THE INTERVIEW

Provide a brief introduction to the research project and the role of the interviews within this project. Briefly explain the derivation of the key knowledge management skills from the broader research literature and previous training development projects. Outline the general sequence of the interview, beginning with the identification of critical incidents and culminating with the identification and articulation of key knowledge management skills.

STEP 2: PROVIDE INTERVIEW PARTICIPANTS WITH SKILL DEFINITIONS

Define each of the knowledge management skills in terms of (a) the types of mental activities, social interactions, or actions involved in displaying the skill, (b) the general triggering cues or conditions that form the context for exhibiting the skill, (c) the general types of knowledge elements produced by the skill, and (d) the desired standards for performing the skill. [Note: interview participants will have completed a survey questionnaire regarding these thinking skills prior to the face-to-face interview. They will be asked to make personal notes on the survey form and to refer to these notes during the interview. It is anticipated that their survey responses and personal notes will serve as a prompt for triggering thoughts and experiences during the interview.]

STEP 3: ELICIT CRITICAL INCIDENT DESCRIPTIONS

Using each of the operational scenario contexts outlined in the proposal (i.e., deliberate attack, asymmetric insurgency, stability and reconstruction), the participant will be asked to recall and describe from past experience one or more critical incidents believed to have involved a critical knowledge management skill. A critical incident is defined here as an incident or episode in which the command team (a) developed critical understanding or insight into some aspect of the operation, (b) used this understanding or insight to form a critical decision involving future operations, and (c) the decision led to a significant operational outcome.

Next, the participant will be asked to think of a second set of critical incidents in which the command team failed to accomplish one or more of these steps—i.e., failed to gain critical understanding or insight, failed to translate this understanding or insight into a critical decision, and/or a negative or unanticipated outcome occurred.

As part of the incident description, the participant will be asked to describe the general nature of the operational context or problem space in which the incident occurred. The context will be classified into one of the four quadrants identified from the sense-making strategy framework: *known situation*, *knowable situation*, *complex situation*, *chaotic situation*.[8] This will provide the context for developing the "task conditions" part of the skill training. [Note: it will be useful for a DRC member to record these incidents in chart form in order to provide a framework for the remainder of the interview.]

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[8] See Figure 1 attached to this interview guide.

STEP 4: IDENTIFY KEY SKILLS EMPLOYED (OR NOT EMPLOYED) WITHIN CRITICAL INCIDENTS

Considering each of the critical incidents identified in Step 2, the participant will be asked to consider the list of knowledge management skills and to identify from this list a rank-ordered subset of the skills deemed to be involved in the incident. The rank-ordering will be in terms of the perceived degree of importance or criticality of the skill to the incident. A subset of relevant skills will be identified for both the positive incident examples and the negative incident examples.

As a final step, the participant will be asked to identify any relevant knowledge management skills not already covered by the list of key skills developed by DRC.

STEP 5: ARTICULATE KEY SKILLS IN TERMS OF COGNITIVE ELEMENTS

In the final step in the interview, the participant will be asked to articulate the identified subset of relevant skills for each critical incident in terms of the following elements:

Skill Type	Details to be Articulated within the Context of the Critical Incident
Framing the Decision Space	Identify and describe each of the relevant cues/triggers that led to the activation of a mental model or paradigm used to frame understanding. Describe the mental model or paradigm and illustrate how it was used to filter, highlight, structure, or interpret available information. Identify any specific predictions that were made on the basis of these models or paradigms.
Defining Relevant Problem Elements	Identify the major constructs involved in picturing the operational environment. That is, identify the manner in which mission objectives were decomposed into personally meaningful centers of gravity, key elements, functions, objects, etc. It is envisioned that every commander or officer will have developed some type of abstract decomposition of the operational environment. The object here is to get them to describe their version of it, not impose some prescribed framework.
Defining Operational Pathways	Identify the major issues involved in the incident. Illustrate how these issues were associated with specific objectives, obstacles, key events, and desired end states. If possible, show how these issues were linked over time or linked in terms of operational pathways.
Handling Risk and Uncertainty	Identify the operational environment information considered relevant to the incident. Discuss how the mental models or paradigms (identified earlier) served to guide decisions about which pieces of information were critical to achieving the level of confidence needed for making command decisions. Discuss, if relevant, how the value of specific pieces of information was balanced against the time/effort needed to collect the information.

Validating/Revising Decision Framework	Identify how the available pieces of information served to either validate the mental models and paradigms, or led to the revision of these models and paradigms. Identify any types of contingencies that emerged during the development of situation awareness and understanding. Discuss what types of strategies were used to deal with these contingencies. Identify any conflicting information that arose during the incident and discuss how this information was treated –ignored? – reinterpreted based on existing situation understanding? –used to significantly alter the situation under-standing? – served to deviate the operation from original mission goals?
Forming Critical Process of Collaboration	Identify which members of the battalion command team contributed to the development of situation awareness and understanding during the incident. Identify any other sources of expertise or information that contributed significantly (or failed to contribute) to this process. Identify the general form of collaboration—e.g., democratic (all contributed proactively), authoritarian (dominated by one individual).
Identifying Critical Linkages/Relationships	Referencing the work domain structure (described earlier), identify the key elements of knowledge at each level of abstraction that dominated the thinking of the command team. Discuss the extent to which these key knowledge elements fell across different PMESII[9] dimensions of the operational environment. Discuss how effects and actions were linked across different PMESII dimensions in any significant way.
Identify/Resolve Collaboration Barriers	Identify any cognitive, social, organizational, or technical obstacles that inhibited effective collaboration of the group members (identified earlier). Discuss if (and how) these obstacles were overcome during the incident. Identify which individuals within the battalion command team identified the obstacles and took the initiative to redress them.
Monitoring/Adjusting Knowledge Mgmt Process	Discuss how (and by whom) the knowledge creation process within the battalion was monitored and adjusted during the incident. Identify any points during the incident at which the sense-making strategy shifted between *known*, *knowable*, *complex*, and *chaotic*. What elements of the situation (or what information or expertise) caused this shift to occur?
Articulating/ Communicating Actionable Knowledge	Discuss to what extent the internal (tacit) understanding developed within the battalion command team was explicitly codified in terms of directives, guidance, and orders. Discuss the degree to which this level of codification adequately served to guide subsequent decisions and actions by the battalion. Identify any areas of this awareness and understanding that were ambiguously or inadequately communicated to others.

[9] PMESII – Political, Military, Economic, Social, Information, Infrastructure

Identifying/Adjusting Shaping Actions	Identify any actions that were taken by the battalion during the incident to shape the operational environment in conformance with the mental models and paradigms used to frame situational awareness and understanding—e.g., economic actions were taken because the situation was deemed to be driven by economic issues, even though there were military or social implications and effects. To what extent did events and conditions within the operational environment conform to predictions?
Identifying/Adjusting Probing Actions	Identify any actions that were taken by the battalion during the incident that served to probe or experimentally test the operational environment. How were these actions related to the mental models and paradigms used to frame situational awareness and understanding? Discuss how the battalion received and acted upon feedback generated by these actions.
Discovering/Exploiting Opportunities	Identify any specific insights gained during the incident regarding the causal dynamics operating within the operational environment. Discuss how (and to what extent) these insights were subsequently exploited for operational advantage.

STEP 6: REVIEW SURVEY RESPONSES

After allowing the participant to describe in detail several critical incidents, a portion of the remaining time will focus on reviewing the participant's responses to the survey questionnaire that had been provided prior to the interview. Specifically, the participant will be asked to explain responses related to thinking skills not specifically addressed in the critical incident discussions. Additionally, the participant will be asked to explain their responses to the last set of survey questions addressed uniquely tailored to each thinking skill.

STEP 7: ADDITIONAL COMMENTS

Allow the interview participant the opportunity to make any additional comments deemed relevant to knowledge management within the battalion.

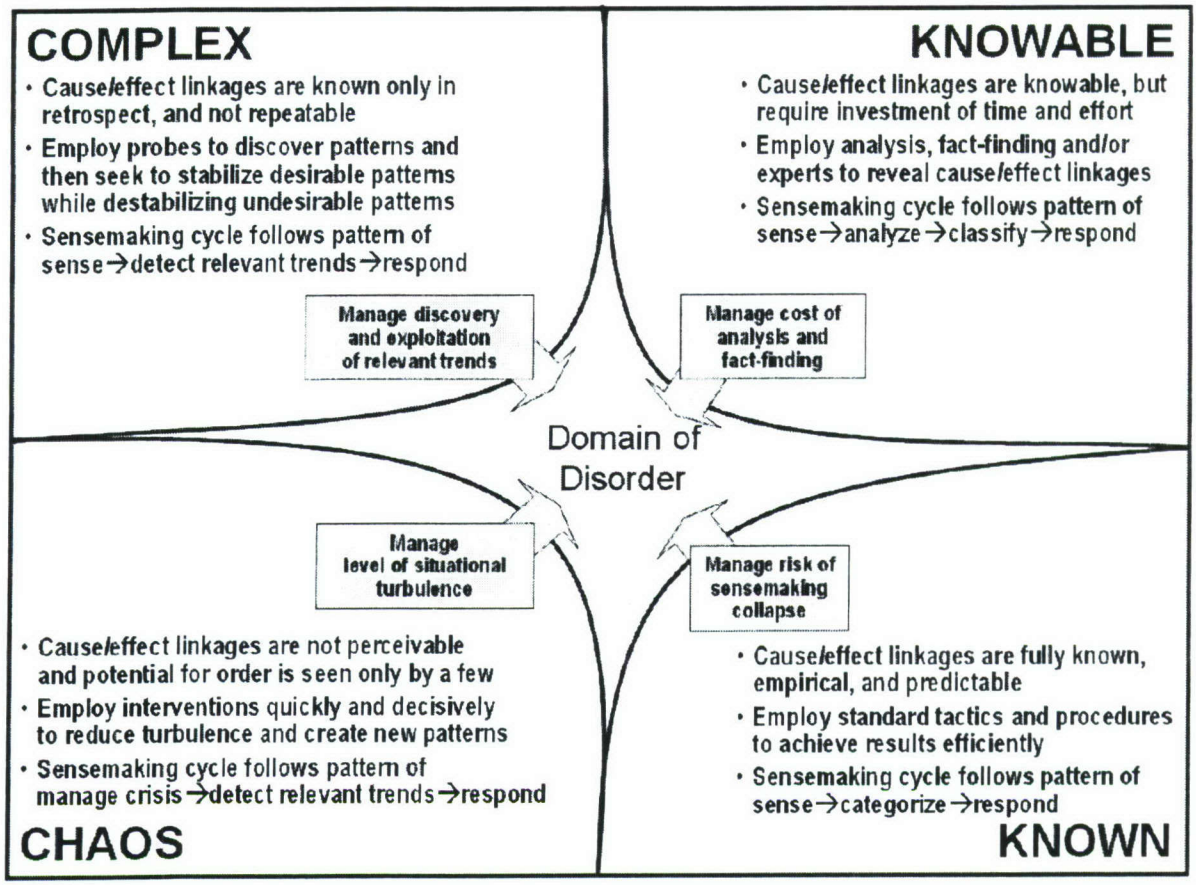

Figure B-1. Sense-making Strategy Quadrants (Adapted from Kurtz & Snowden, 2003).